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ABSTRACT

A revised edition of PS-14, "An Introduction to Benefit-Cost Analysis for Evaluating Public Programs," presents concepts and techniques of benefit-cost analysis as tools that can be used to assist in deciding between alternatives. The goals of the new edition include teaching students to think about the possible benefits and costs of each alternative; to define what they foresee as program outputs and to consider possible undesirable consequences; and to recognize the trade-offs that are implicit in all decisions. Topics of the eight modules (16 exercises) include the following: classifying direct vs. indirect benefits, as well as tangibles vs. intangibles; pecuniary or price effects; the business model of benefit-costs analysis; business as a model for government decisions; supply and demand in the market for goods; challenges for valuation presented by government programs; the comparison of costs and benefits that occur at different times; shadow pricing; double-counting, and benefits valued as net savings. Everyday examples are used to present what are frequently difficult concepts and relationships for the student with little background in economics. A sample student evaluation form is appended. (Author/SW)

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PS 22

AN INTRODUCTION TO BENEFIT-COST ANALYSIS FOR EVALUATING PUBLIC EXPENDITURE ALTERNATIVES

by
Josephine M. LaPlante
and
Taylor R. Durham

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This completely revised edition of PS-14, An Introduction to Benefit-Cost Analysis for Evaluating Public Programs, presents the fundamental concepts and techniques of benefit-cost analysis as tools which can be used to assist in deciding between alternatives. The goals of the new edition include teaching students to think about the various possible benefits and costs of each alternative under consideration; to define what they foresee as program outputs and to consider possible undesirable consequences; and finally, to recognize the trade-offs which are implicit in all decisions. The package relies on everyday examples to present what are frequently difficult concepts and relationships for the student with little background in economics.

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TO THE INSTRUCTOR AND STUDENTS:

THE PRIMARY OBJECTIVE:

To introduce the techniques of benefit-cost analysis as useful tools for structuring a decision-making framework in a wide variety of situations, where alternatives need to be evaluated and a choice made on the best course of action.

UPON COMPLETION OF THIS PACKAGE, THE STUDENT WILL BE ABLE TO:

*Recognize the sacrifices (opportunity costs) which occur when one course of action is chosen over its alternative.

*Identify situations where application of the tools of benefit-cost analysis can improve the quality of decisions.

*Recognize the need for, but difficulties encountered in, assigning "benefits" and "costs" to all features of alternative choices.

*Apply the technique of "discounting" to allow adequate comparison of benefits and costs which do not occur at the same point in time.

*Evaluate with critical insight the claims of program proponents for anticipated benefits and costs.

ADDITIONAL MATERIALS REQUIRED:

None.

TIME SPAN:

Two to three weeks.

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INTRODUCTION

The recent cutbacks in federally funded programs, tax limitation movements and the continued fiscal problems of cities have focused nationwide attention on how to do more with less money. The problem of how to make the most of limited resources is not really new: any of us who have to live within a budget are already familiar with the intricacies of juggling expenditures. The process of deciding whether to undertake a course of action can be made more systematic and thereby hopefully yield a better decision by applying some of the techniques of benefit-cost analysis.

Benefit-cost analysis is essentially a framework for decision making which requires the decision-maker to carefully consider all of the possible consequences of a given decision. Benefit-cost analysis first requires that anyone considering a particular course of action explicitly state what he or she expects the benefits to be. Then, all of the possible negative consequences (costs) must be specified. Once both the benefits and costs of a project or undertaking have been identified, a comparison may be made and the "net benefit" or gain determined. If the net benefit is positive, the project is "worth" doing. Whether used in a rather intuitive way in our daily decision making or in a more formal way in public expenditure decision making, benefit-cost analysis provides the basis for more informed choices.

This learning package will teach you the key concepts and basic techniques of benefit-cost analysis. Although the package is "introductory," once you have mastered the material presented you will be able to begin using benefit-cost analysis to assist in decision making. Whether you are a governmental agency staff person trying to decide between two program alternatives or a student budgeting time and money, putting your alternatives into the benefit-cost framework can be valuable. Perhaps one of its more positive benefits is that it forces us to be explicit about our expectations for a project. A clear cut statement of anticipated benefits and costs can provide the basis for both constructive debate during the initial decision making and later as a guide against which programs may be evaluated.

Benefit-cost analysis has not been universally accepted as the way to make choices about government programs. However, most of the debate occurring over benefit-cost analysis through

the years focuses on philosophical and methodological issues which are frequently beyond the day-to-day problems facing us as decision-makers. A question such as "How much value do we attach to a human life?" is an important consideration when a public project which might save lives is being debated, but it is not one easily answered within the benefit-cost framework. The difficulty of applying benefit-cost analysis in some situations, however, does not lessen the great assistance it can give in others. Like any tool, benefit-cost analysis is best used in situations which call for its particular capabilities. While benefit-cost analysis can be very useful in trying to decide between two projects that achieve the same objectives, its usefulness wanes as the objectives of projects under consideration diverge. Remembering the old adage that you cannot compare apples and oranges is the key to using benefit-cost analysis wisely and well.

This learning package is a completely revised version of PS-14, An Introduction to Benefit-Cost Analysis for Evaluating Public Programs.

MODULE I: AN INTRODUCTION TO THE USE OF BENEFIT-COST ANALYSIS FOR DECISION MAKING

Problems of insufficient money, time or other resources plague all of us, regardless of our particular role as a decision-maker. If you have had a course in economics, you are no doubt familiar with the frequently stated goal of "efficient utilization of scarce resources." Efficient utilization of resources simply means achieving the desired outcome with minimum waste, something we're all concerned about. Economists have developed a tool or technique to help us make the most efficient use of our resources called benefit-cost analysis. This section introduces the basic concept of benefit-cost analysis. Later modules will cover the various principles and methods.

1.1 Defining Benefits and Costs

Since resources of all types are limited, deciding to use a resource in one way precludes using that resource in another way. For example, if you have $6 and choose to spend it on a record album, you cannot also use the same money to purchase a book. Choosing the record over the book requires a sacrifice on your part since you must forego the book to obtain the record. The benefit which you might have obtained from the book is the opportunity cost of your decision to purchase the record. Very simply stated, an opportunity cost is a foregone or sacrificed opportunity.

Opportunity costs are inherent in all decisions because resources are limited. Even the acceptance of a free record album may indirectly incur an opportunity cost since using the gift will require time. Choosing to use time to listen to the album will prevent you from using your time to do something else. The fact that you choose to listen to the record shows that you derive a benefit from that use of your time. The cost of using your time listening to the album might be sacrificed study time and perhaps a lower grade on an exam. Thus, we may define benefits and costs as follows:

> BENEFITS are anything you gain by undertaking a particular course of action.

COSTS are anything you must give up in order to obtain those benefits.

Remember that every choice situation will involve some opportunity cost -- trading the benefits that might be obtained by choosing one course of action for those of another. Benefit-cost analysis is a tool to help us make the choice of one alternative over another with some degree of certainty that what we give up is not more valuable than what we choose.

1.2 An Informal Application of Benefit-Cost Analysis

Benefit-cost analysis is a technique which requires one to systematically identify all of the benefits and costs of the alternatives under consideration. The idea of systematic identification is the key to a useful benefit-cost analysis: a careful, methodical sequence is followed in determining benefits and costs, not a haphazard or capicious route. The best information is needed to make the best choice. Once the benefits and costs are tallied, the following decision rule can be used to decide whether to choose the alternative being considered:

AN ALTERNATIVE SHOULD BE UNDERTAKEN ONLY IF
ITS BENEFITS ARE AT LEAST EQUAL TO ITS COSTS

This rule is simply what common sense dictates: since the costs of a particular alternative are comprised of an estimate of foregone benefits, the costs must be less than the benefits or we gain nothing.

The following hypothetical situation which you may face someday should illustrate more clearly how benefit-cost analysis can aid in making a good choice:

> John, a graduating senior, has been planning to attend graduate school to obtain a Master's degree in Public Administration. He has just been offered a position at a public agency where he has been working as an intern. The position offers a good starting salary and various fringe benefits, including a tuition reimbursement program for coursework related to the job. There is also room for advancement within the agency. However, John believes that he would have been offered a more challenging position if he'd had a Master's degree.

What are the benefits and costs which John should consider? There are a number of possible benefits which John no doubt hopes to obtain by investing his time and committing his financial re-

sources to an additional year in school. These benefits might include the following:

BENEFITS

(1) POTENTIAL HIGHER LIFETIME EARNINGS.

(2) IMPROVED JOB SEEKING STATUS (AN "EDGE" ON THE JOB MARKET).

(3) INCREASED KNOWLEDGE.

(4) PERSONAL SATISFACTION.

(5) PRESTIGE.

The costs of deciding to attend school rather than working are for the most part simply the benefits of working which he must give up:

COSTS

(1) VALUE OF RESOURCES USED TO PAY TUITION FEES AND BUY BOOKS.

(2) VALUE OF ANY RESOURCES USED FOR LIVING EXPENSES WHICH ARE OVER AND ABOVE LIVING EXPENSES INCURRED WHEN NOT ATTENDING SCHOOL.

(3) LOSS OF EARNINGS FROM EMPLOYMENT.

(4) LOSS OF TUITION REIMBURSEMENT.

(5) LOSS OF WORK EXPERIENCE.

The question facing John is whether the benefits of attending graduate school are at least equal to the costs. Obviously, such a decision will depend on his personal valuation of each benefit and cost. While the actual decision in a case such as this largely depends on personal preferences, the decision may be made in a much more informed way through the systematic identification of all benefits and costs.

EXERCISE 1: Which of the benefits and costs facing John would you value most highly? What other benefits or costs would you include? What do you think John should do?

MODULE II: CLASSES OF BENEFITS AND COSTS

In Module I we were concerned with identifying all of the benefits and costs of alternative choices. In identifying benefits and costs it is not only necessary to make the list complete, but also to be sure that all benefits and costs listed are "real." Real benefits and costs are those which represent net gains or losses to the individual or group affected by the project. Increased earnings are a real gain. Sacrificing the possibility to gain experience is a real loss to a student who attends graduate school rather than accepting employment. Real benefits and costs may be divided into categories depending on:

(1) Whether they represent intended program effects (direct versus indirect) and,

(2) Whether the nature of the benefit or cost allows its value to be translated into dollars (tangible versus intangible).

This module will teach you to distinguish real benefits and costs from those which are not real, and to classify real project effects into direct versus indirect and tangible versus intangible.

2.1 Classifying Real Benefits and Costs

A. DIRECT VS. INDIRECT

The objectives of a project -- that is, why the project may be undertaken -- determine whether the benefits and costs are direct or indirect. Direct benefits and costs are directly related to the objectives of the project. Direct benefits are the primary or intended effects which the program is planned to achieve. Higher earnings would be a direct benefit of education. Indirect benefits and costs are secondary effects which occur in addition to the direct or primary effects. For example, a project may be directed principally towards flood control but it coincidentally reduces soil erosion. Thus, indirect effects are in this case real effects and should, of course, be included as benefits. If a project produces undesirable or negative effects, such as increased soil erosion, the value of this real

effect should be included as a cost.

The indirect or secondary label is often used when discussing public projects to refer to effects which are not appropriately included in the estimation of benefits (or costs). These may take the form of expenditure or income effects, and often are called "multiplier effects." The "multiplier process" works as follows: a dollar of spending on a project -- to pay labor or buy materials -- becomes income to the seller. Usually, the recipient of income (new income, since the project represents spending which otherwise would not have occurred) will spend some fraction of it on something, thus providing new or extra income for someone else. This spending and re-spending sequence can, in effect, "multiply" the amount of original project spending several times (representative multipliers presented in benefit/cost studies range between 1-1/2 and 3). However, this does not measure additional real benefits attributable to the project, and thus is not a legitimate benefit.

Often the multiplier effect is included to show the impact of a project on a particular region. Since regional development may be an objective, this is not erroneous; however, it is not a "benefit" in the sense we use the word. Different project types or methods of implementation may have different multiplier effects on a region. If workers must be imported and most of their spending will occur outside the region, the multiplier effect will be reduced locally. The same is true if materials must be brought in and used in place of local resources. Depending on the objectives and scope of project planning, information of this sort may be useful in assessing distributional (who gains and who loses) rather than benefit aspects of the project.

B. TANGIBLES VS. INTANGIBLES

Both direct and indirect project benefits and costs may be further categorized as either tangible or intangible. A tangible benefit or cost is one whose value can be translated into dollar terms, i.e., quantified. While the process of assigning dollar values to tangibles is not an easy one, it is possible to estimate monetary values. For example, potential increased earnings is a tangible benefit of education. While the value is obviously the monetary gain, the assignment of a dollar amount involves projections about future employment, and so forth. The fact that it may be difficult to estimate the actual dollar value does not change the tangible nature of a benefit or cost.

An intangible benefit or cost is nonmonetary in nature. The benefit or cost does have "value," but not a value to which a dollar tag could be realistically or even ethically attached. Examples of intangibles include such benefits as prestige and

increased satisfaction, and such costs as loss of opportunity to increase knowledge.

The classification of the value of a benefit or cost as tangible or intangible does not in any way indicate "importance." Frequently, intangible benefits and costs of projects are at least as important as tangible effects. Since many arguments about public projects revolve around the expenditure of public funds, it is not surprising that tangible effects are frequently in the spotlight. The importance of intangible effects can easily be obscured. A systematic delineation of all benefits and costs can help keep all of a project's effects in the proper perspective.

EXERCISE 2: Indicate whether each of the following benefits or costs is tangible or intangible and why:

(a) Increased farm output.

(b) Loss of wilderness.

(c) Preservation of small business (and thus jobs).

(d) Saved travel time for people who drive for a living (e.g., traveling salesman).

2.2 Pecuniary or "Price" Effects

When a new highway is proposed which will divert traffic away from another road, there may be an outcry from merchants whose businesses are located on the old road. When the new highway is completed, motels, gas stations and shops along the new route receive increased business. As feared, similar businesses along the old route experience a serious drop in sales. Do you think the loss of those businesses should be included in the total project costs?

The answer is no, in most instances. If the area affected is the central business district of a city and preservation of

the central city is an important planning consideration, the effect on businesses might be included. For the most part, such price effects are not included. The construction of a new highway influences the demand for services and thus their prices. Prices change relative to the prices of other services. Generally, someone's loss is offset by someone else's gain. These effects are called pecuniary benefits and costs and should be distinguished from real project effects.

Making the distinction between real project effects and pecuniary effects is a major initial step in measuring benefits (or costs) appropriately. Pecuniary effects do not represent real net gains (or losses) to the group of people affected by a project. Some individuals may feel favorably or adversely affected, and rightly so. However, the pecuniary effect represents a redistribution among the members of the group, not a real gain or loss. Generally, such pecuniary effects are to be excluded from measures or benefits (or costs). Often, including them will result in "double-counting," since the real effects which give rise to the redistribution have already been counted.

Suppose the building of a bridge into a city causes a rise in rents for residential property which now has newly improved access to the city. These increases in rent will occur as people seek to relocate along the improved access route, in order to save on commuter time and hassle over the routes from their current places of residence. Presumably, rents in the now relatively less attractive areas will decline as people relocate, offsetting the rise in rents adjacent to the bridge route. (Note that the reason for the shift in population residence is the savings in time and bother -- which will have been included already in the estimation of benefits provided by building the bridge.)

EXERCISE 3: In the early 1960's, the Verrazano Bridge was built connecting Brooklyn with Staten Island. People traveling to Staten Island no longer needed to drive through lower Manhattan. Staten Island is also connected to northern New Jersey by several bridges. Indicate which of the following project effects are real and which are pecuniary and explain:

(a) Commuters from Long Island to New Jersey saved time traveling to and from work.

(b) Housing prices on Staten Island increased.

(c) The Staten Island Ferry experienced a decline in revenues.

(d) The City of New York was not able to construct an alternative bridge they had been considering uptown.

MODULE III: GOVERNMENT PROJECTS AND THE BUSINESS APPROACH TO BENEFIT-COST ANALYSIS

This module will compare business investments with government programs, and present a rationale for evaluating government programs in a way analogous to business evaluation of investment decisions.

3.1 The General Choice Problem

Government programs are designed to accomplish certain goals or aims through their effects, often identified with particular areas such as health, education, transportation, defense and justice. The dollars that the government spends on one program could just as easily have been spent elsewhere. For this reason, government is faced with the basic problem of deciding how much of some programs must be given up in order to further accomplishments in other areas. If the government wishes to get the most for the dollars it spends over all these programs, it is immediately confronted with two difficulties:

(1) The aims of these programs are often quite different, and since opportunity cost demands comparison, it is necessary to compare gains in one area with what must be given up in other areas.

(2) The government is concerned with getting the most for numerous and diverse individuals, each of whom may entertain rather distinctive notions about what is worth doing and what is not.

The problem is to assess opportunity cost to obtain the maximum benefits for the people for whom the government acts as an agent. This presents two difficulties:

(1) Comparability, or measuring the results of seemingly diverse programs in some way which permits comparisons of what is given up with what is gained.

(2) Aggregation, the adding up of benefits (or costs) which accrue to numerous and often quite different people.

As we shall see, these problems are dealt with in benefit-cost by using a particular means of quantifying benefits and costs.

3.2 The Business Model of Benefit-Cost Analysis

Profits represent the difference between total revenue (what business gets for what it sells) and total costs (P = TR - TC). A business will increase its total profits if it can sell units of outputs (products) which add more to total revenue from sales than the units themselves cost to produce. That is, each unit which adds more total revenue than it costs to produce will contribute to increased profits. Furthermore, if a business has several different products to sell, it will increase its profit the most by selling additional units of the products which add the most to profits , i.e., for which the difference between the selling price and cost per unit for production is greatest. If the business uses its resources (incurs costs) to produce and sell a unit of one product which adds less to total profits than another product could have for the same costs, it has made a bad deal. The opportunity cost of the unit actually produced is the greater addition to profit which could have been gained by selling the other products.

If a business sells all units of a particular product at one price, then its total revenues (TR) will be equal to the number of units (Q) sold, multiplied by the selling price (P): (TR = P x Q). If a business is deciding which of two products it will produce with a fixed budget, it will, of course, select that product for which it believes TR - TC will be the greatest. The business' belief about which will be the best product to put on the market will depend on all sorts of estimates as to how much it will be able to produce, at what price it can expect to sell its output, what prices must be paid for the necessary inputs, and so forth.

However, few businesses consider it sufficient to measure their success only on the basis of their profit record in a single year. Businesses are usually interested in getting more business (and profit) in the future. And if a business wishes to sell more goods in the future, it must also have the capacity to undertake the necessary additional production.

Consequently, most businesses make investments (here defined as the expenditure of funds not for the purpose of augmenting

current production and sales, but to increase the capacity to produce goods or services in the future). Such investments generally take the form of new plants, machinery, equipment, labor training programs or materials development which, while making new productive capacity, use resources which could have been used to produce additional goods and services for sale in the current time period. Thus, these investments require the exchange of current consumption of some goods and services for increased availability of goods and services in the future.

Benefits which are foregone in order to undertake these investments represent the opportunity cost. We will see shortly that one test an investment should pass is that the value of the additional future output should be sufficiently great to compensate for the opportunity cost of making the investment -- i.e., that people will accept the exchange of current consumption for these future consumption benefits.

The calculations that businesses go through in deciding what investments to make actually do involve estimating whether the investment is worthwhile in terms of opportunity cost. When calculating its potential profit from an investment, a business does not simply subtract total costs from total revenues to obtain profits gained in a single period. This is because most of the costs of many types of investment must be committed long before most of the revenue resulting from sales made possible by the investment is realized by the firm. This means that the firm must find a method for comparing these future revenues with the presently incurred costs of the investment. Since the true cost of the investment from the consumers' point of view are equal to the current consumption sacrificed, it is desirable that this comparison be made between future consumption benefits and those current consumption benefits which could have been made or realized had the investment not been undertaken.

3.3 Business As a Model for Government Decisions

It might still be asked, why compare government programs with private business investments and profit-making? The rationale is fairly straightforward. Business believes it sells things that people want. When government does something, it does so by employing people and buying materials with funds it has obtained from taxing or borrowing. If it obtains funds by taxing either businesses or individuals, this simply means that these same businesses or individuals have less money to spend on things that business provides directly to individuals, or to other businesses (eventually to reach individuals). If government borrows money

from individuals, this means there is less for business to borrow (and business borrows to build more plants and machinery to produce more to sell to individuals). Consequently, government simply is using resources -- people, materials, energy, etc. -- to produce things for people. The same resources could have been used by businesses to produce things for people.

On the whole, businesses which do not make a profit do not continue in business for any great length of time. It therefore seems unfair (and a waste of resources) if government does not produce things which, if sold, people would buy in sufficient quantity and at sufficiently high prices so as to cover the costs of production. If the government is not able, through a given program, to accomplish something at least as worthwhile as what business would have accomplished with the same resources, then the program should in all likelihood not have been undertaken.

The benefit-cost approach accepts the validity of comparing government with business with regard to certain types of government activity, although there are important differences which are also recognized (and which present many of the difficulties in a benefit-cost analysis of government programs). The general thrust of benefit-cost analysis is that government investments (programs) should meet tests similar to those employed in the business sector. That is, government should undertake programs which compare favorably as to returns ("profit" or payoff) with those which would have been undertaken in the private sector, had the resources not been transferred to government purposes. Furthermore, government should endeavor to select those program alternatives available to it which will maximize the gain or value produced using the resources transferred from private sector uses. This government goal contributes to a general social goal (encompassing private and public activities) to maximize the value of outputs from limited resources.

This guideline is not always easy to abide by in practice, even discounting political considerations. Many outputs of government programs are not sold; indeed, as we shall see, these outputs often cannot be sold in the usual ways, either because it would be technically difficult or expensive to do so (e.g., to sell clean air) or because such a sale would violate basic societal principles (e.g., to establish a form of slavery in which the government would be required to sell the results of its investments in education or job-training programs). In addition, what people buy is often influenced substantially by their income, and it may be that a society will decide that there are things which should be provided at some minimal level by the government to everyone, regardless of his ability to pay. Finally, government is obligated to take account of all real benefits and costs to whomsoever they may accrue, whether or not they are paid for (or even perceived). Many such benefits or costs are "intangibles" (effects for which

there is no established market -- no quantities exchanged for some price), which are not easily identified, much less quantified. This emphasis on including all costs and benefits is the basis for distinguishing between private and social cost -- i.e., benefit calculations. A private decision-maker (whether business firm or individual consumer) typically takes into account only those benefits which he alone receives, and only those costs which he alone must pay.

EXERCISE 4: List three similarities and three differences between business and government:

Similarities:

(1)

(2)

(3)

Differences:

(1)

(2)

(3)

MODULE IV: USING DOLLAR PRICES TO QUANTIFY BENEFITS AND COSTS

The comparison of costs and benefits of a particular project alternative frequently requires more than an intuitive weighting of the benefits and costs. The quantification, or translation into dollar amounts, of benefits and costs is not always a simple task. Our discussion of the business model for government decisions suggests one method: use market prices to evaluate program outputs. This permits comparison of government programs among themselves and also with products or services which consumers purchase from businesses. Although many government programs may not produce saleable outputs, it might be possible to estimate prices which would be paid for such outputs, under certain specified conditions. This section will discuss the underlying rationale for using prices (actual market prices or estimated prices) to obtain quantifiable values for government program outputs. Since the costs of choosing one program are equal to the foregone benefits of its alternative, we will talk in terms of benefits, but the methods can be used for estimating costs (or negative benefits) as well. The aim of the discussion is to demonstrate that the total benefits provided by a government program may be approximated by estimating the total revenue which would be collected for the program's output or services if they could be sold at some positive price.

4.1 Supply and Demand in the Market for Goods

The supply of a particular good and the demand for that good defines a market for that commodity. How much of a particular item will be sold, and at what price, depends on two factors:

(1) The supplier's schedule of how much he can afford to offer for sale at each price, and

(2) The consumer's schedule of how much he can buy at each price.

The supply schedule or curve is basically determined by the producer's costs: how much he must pay for labor and other resources used in production, plus an amount to cover his own

entrepreneurial input. The marginal costs, or the cost of each additional unit of output, generally increase as production increases. Thus, the supply schedule of the producer typically will slant upward, indicating that as the quantity he offers for sale increases the price increases as well. Figure 4.1 shows a supply curve.

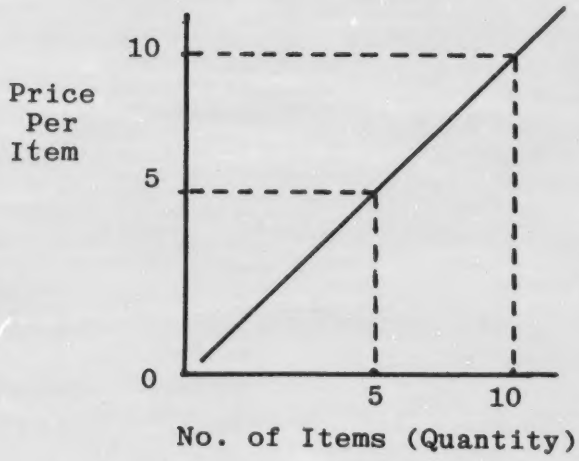


Figure 4.1: Supply Curve

This graph shows that if five units are offered for sale, the producer will want $5 per unit, but ten units will require $10 per unit.

The consumer's demand schedule or curve is determined by several factors including personal taste, income, and availability of substitutes and the price of substitutes. At any given price, there will be a quantity which the consumer will be willing to purchase. For most types of goods, consumers will be willing to purchase more items at lower prices. Thus, the demand schedule generally slants downward, indicating that as the price falls,

the quantity demanded increases. Figure 4.2 shows a typical demand schedule.

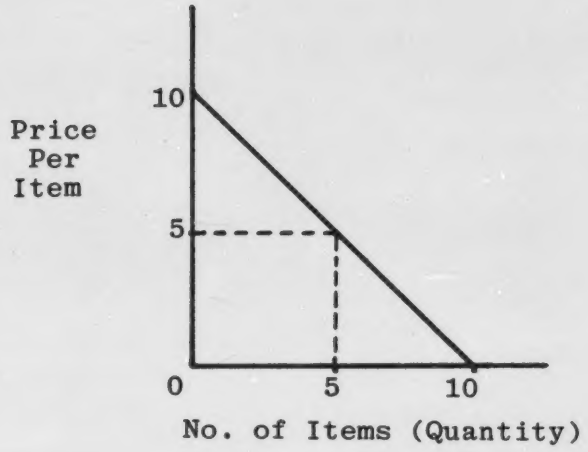


Figure 4.2: Demand Curve

Since producers want more money per unit when they offer additional items for sale and consumers buy less as prices increase, some compromise must be reached or the items won't get sold. The point of "compromise" is called the equilibrium price-quantity combination.

If we superimpose Figures 4.1 and 4.2 on the other, we see in Figure 4.3, where the supply and demand schedules intersect at a single point. This intersection point indicates a single price-quantity combination for which the amount that the consumer is willing and able to buy at the price is just equal to the amount that the producer is willing and able to offer for sale at that price. This point is called the equilibrium price-quantity combination.

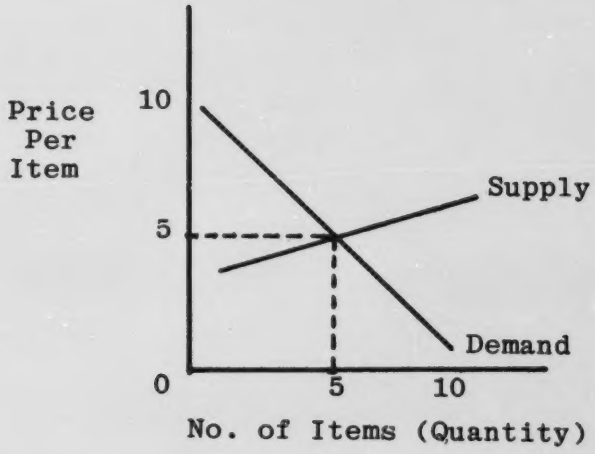


Figure 4.3: The Equilibrium Price-Quantity Combination

The equilibrium price is significant in that it is the one price at which what consumers wish to buy just equals what businesses wish to sell. There is nothing magical about this equilibrium point being reached: if a producer sets his price too high, he won't sell very much. Figure 4.4 shows a situation where excess supply results from too high a price.

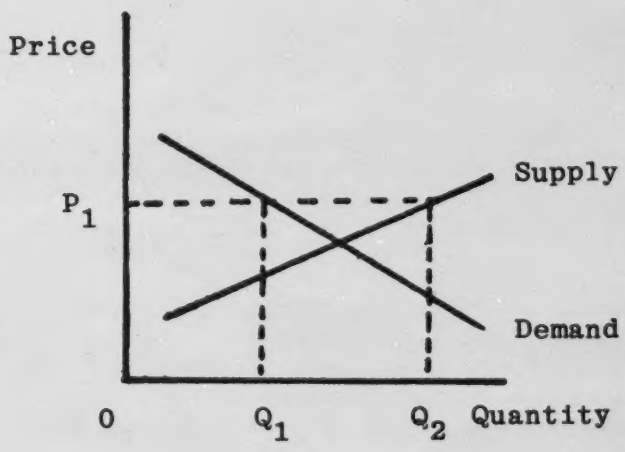


Figure 4.4: Excess Supply

The producer obviously wanted to sell Quantity 2 (Q_2) but was only able to sell Q_1. Thus, the market forces will put downward pressure on his price. A lower price will increase demand and eventually a mutually acceptable price-quantity combination or equilibrium will be reached.

Something of the reverse also occurs when a consumer wants more of a good at a certain price than the producer is willing to sell. Figure 4.5 illustrates a situation of excess demand.

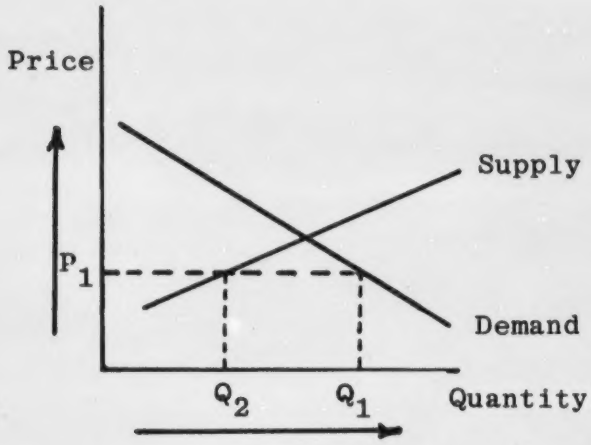


Figure 4.5: Excess Demand

The consumer desires Q_1 at P_1, but can only obtain Q_2 at that price. The excess demand will drive up the price of the good and eventually equilibrium will be reached.

The market for one good with one supplier and one consumer is obviously a very simplified picture which is presented to help you to understand the basic forces at work. Obviously, many consumers and at least a few producers comprise the market for a good. The mechanics do not change much with the addition of buyers and sellers. However, the introduction of substitute goods, or items which can be used interchangeably with the good in question, can change the entire demand schedule. If a readily available substitute is less expensive, consumers will demand less of the original good at any given price. This change is called a shift in the demand for the good, because the quantity demanded at every price changes. The shift can be forward with more demanded at each price, or backward with less demanded at each price. A shift is distinguished from movement along the curve. Movement occurs because price changes causing a change

in quantity demanded, or the quantity demanded causes a change in price. Figure 4.6 illustrates a shift in demand versus movement along the curve.

4.2 Shifts in Supply and Demand Curves

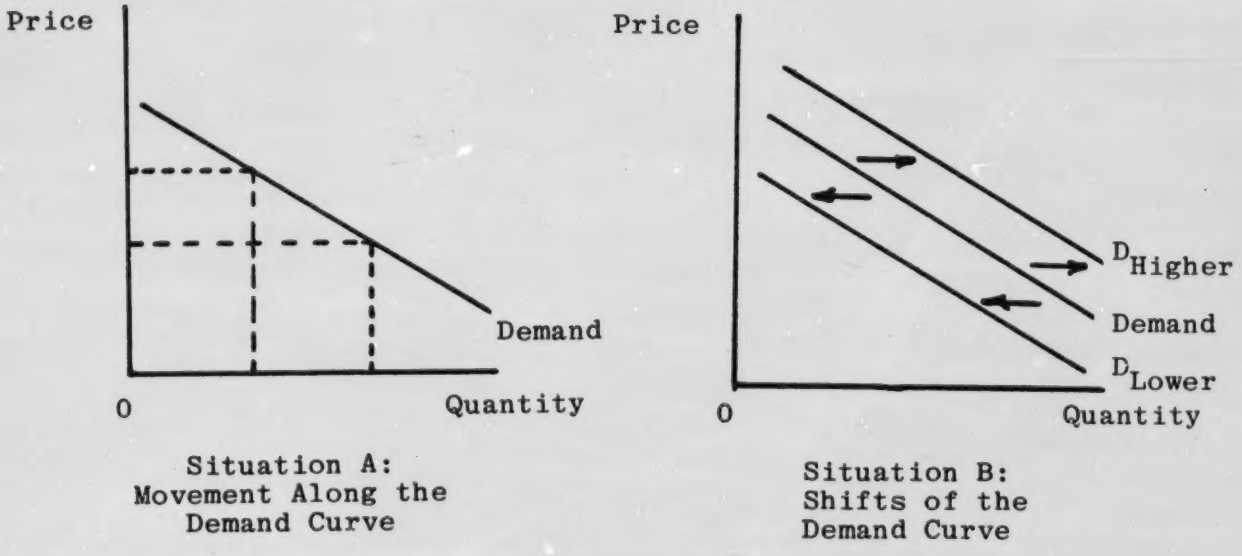
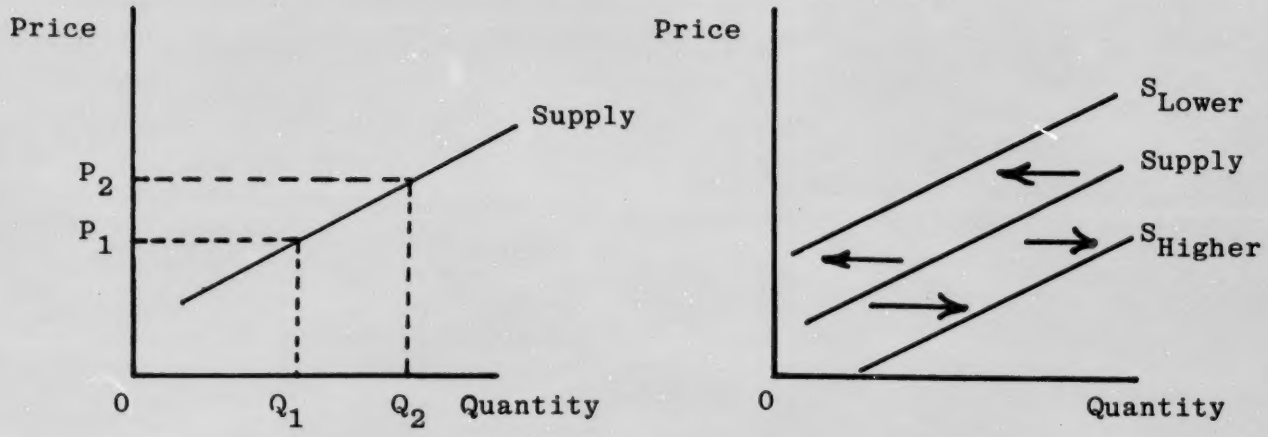


Figure 4.6: Changes in Demand

In Situation A, price increases cause a decrease in the quantity demanded. In Situation B, the actual "demand" for the good changes, causing a shift. A change in the price of substitutes downward would cause the demand curve to shift back to D_{Lower}, so that at any price the amount that would be purchased would be less. If the price of the substitute increased, the demand curve would shift out to D_{Higher}, indicating that more would be purchased at any given price. Changes in any of the other factors which determine the demand schedule, such as income and tastes, can also shift the demand curve.

Shifts in supply also come about because of changes in the determinants of supply, including the cost of labor and other input resources and new technology which result in higher or lower costs to the producer for each quantity. Movements along the supply curve occur when a change in quantity changes the

price. Figure 4.7 illustrates a shift in supply versus a movement along the supply curve.



Situation A:
Movement Along the
Supply Curve

Situation B:
Shifts of the
Supply Curve

Figure 4.7: Changes in Supply

In Situation A, an increase in the quantity (Q_1 to Q_2) sold is accompanied by an increase in price (P_1 to P_2). In Situation B, a change in one of the determinants of supply, perhaps an improvement in technology, shifts the entire supply curve to S_{Higher}, where extra quantity can be offered at any given price. On the other hand, an increase in the cost of labor, for example, could shift the entire curve back to S_{Lower}, where less quantity can be offered for sale at any given price.

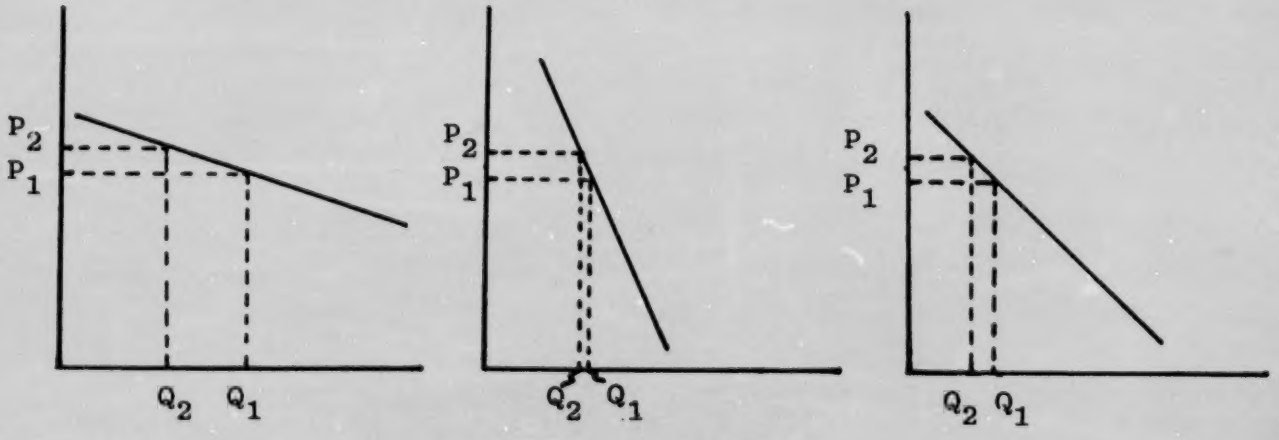
EXERCISE 5:

A. Construct a demand curve, beginning at Price = 100 and Quantity = 0, such that each price reduction of 10 units is associated with an increase in quantity of 10 units. On the same graph, now construct a supply curve, beginning with Price = 0 and Quantity = 0, such that each price increase of 10 units is associated with an increase in quantity of 10 units. End at P = 100 and Q = 100. What is the equilibrium price-quantity combination?

B. Now suppose that the supply curve shifts to the right as a result of a government project, such that at each price, 10 more units will be offered for sale than previously? Construct the new supply curve, S_2, on the graph you constructed earlier. What is the new equilibrium price-quantity combination?

4.3 Elasticity of Supply and Demand

How much will the quantity demanded change as a result of a change in price? Or how much will the price change as a result of a change in the quantity of a good demanded? The answer depends on the elasticity of the supply and demand curves. Elasticity is the responsiveness of changes in quantity to changes in price and vice versa. There are mathematical formulas for determining the actual elasticity of a given curve, but they will not be presented here. What is more important for basic applications of benefit-cost analysis is a more general understanding of how much prices and quantities can be expected to change for particular goods. Let's consider demand for a good first. The steepness or slope of the curve determines the response to a change. Demand for a good is said to be elastic if a small change in price brings about a large change in quantity. For example, an increase in the price of beef may result in a large decrease in the quantity demanded because people buy more chicken and pork. The demand for a good is said to be inelastic if a small change in price brings about an even smaller change in the amount demanded. If all food prices increase, people may reduce their total food intake. However, since there are no readily available substitutes for "food", the decrease in total eating won't be appreciable. If the change in price equals the change in demand, i.e., a one-to-one correspondence, then the curve is unit elastic. Figure 4.8 illustrates the three situations.



Situation A: Elastic

Situation B: Inelastic

Situation C: Unit Elastic

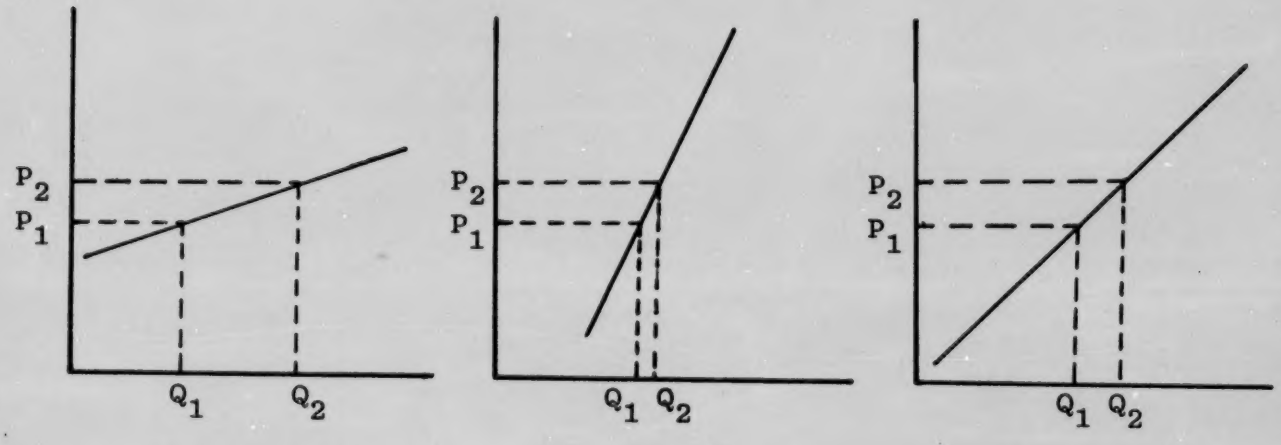
Figure 4.8: Elasticity of Demand

Situation A: Elastic Demand - a small change in price results in a large change in quantity.

Situation B: Inelastic Demand - a small change in price results in an even smaller change in quantity.

Situation C: Unit Elastic Demand - a change in price results in an equal change in quantity demanded.

The elasticity of supply is quite similar, with the amount of the change in quantity offered at each price being determined by the slope of the curve. Figure 4.9 illustrates the different supply elasticities.



Situation A: Elastic

Situation B: Inelastic

Situation C: Unit Elastic

Figure 4.9: Elasticity of Supply

Situation A: Elastic Supply - a small change in price results in a large change in quantity offered.

Situation B: Inelastic Supply - a small change in price results in an even smaller change in quantity offered.

Situation C: Unit Elastic Supply - a change in price results in an equal change in quantity offered.

An example may help tie together some of these aspects of supply and demand analysis. Suppose Congress is considering enacting a special tax on gasoline. This tax will be levied at the pump in the form of a sales tax, thereby increasing the price of gasoline. Congress hopes to bring about a decrease in the consumption of gasoline by raising its price. Do you think Congress will achieve its goal?

The first thing we must consider is the nature of the demand for gasoline. How much of a change in the amount of gasoline purchased can be expected to occur if the price increases? Some people may switch to alternative modes of transportation or form car pools. On the other hand, many people will not be able to cut back much on the use of their cars. Traveling salesmen, truck drivers and others are totally dependent on their cars to make a living. Thus, their demand for gasoline is probably fairly inelastic. An increase in price will not bring about an appreciable change in quantity, as illustrated in Figure 4.9, Situation B.

What if Congress instead places the tax against the gasoline dealers in the form of a special "profits" tax? This will have the effect of raising the dealer's costs and will no doubt raise prices at every quantity. Figure 4.10 compares the two options.

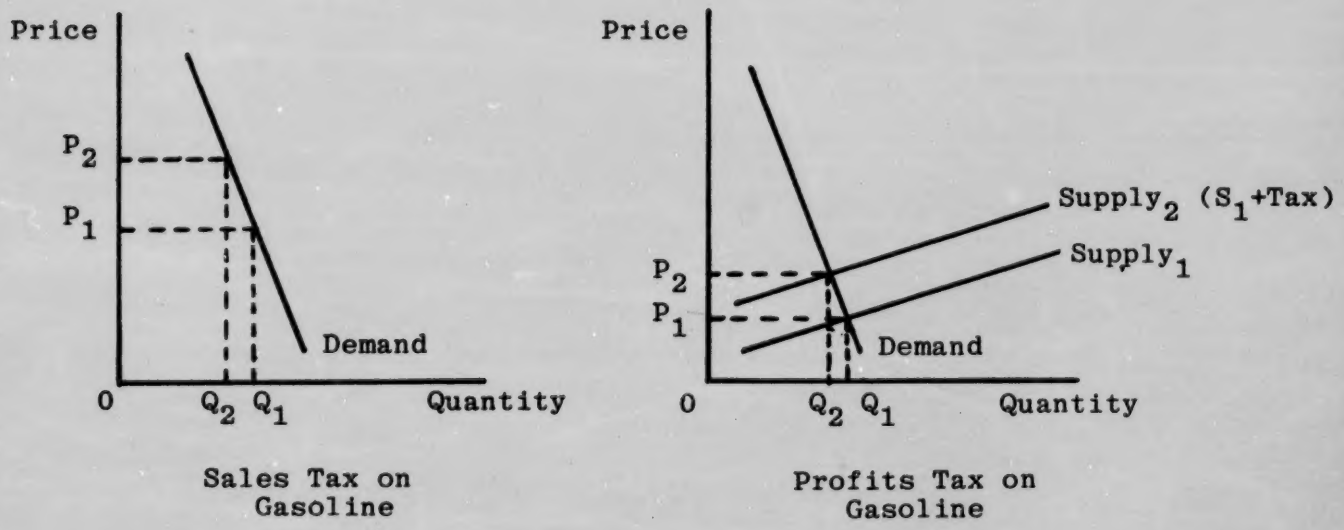


Figure 4.10: Sales Tax Versus Profits Tax on Gasoline

The increased cost of gasoline once again does not bring about much of a change in quantity purchased.

Thus, any cost or benefit estimates which are based upon projected changes in supply and/or demand must first take into account the nature or elasticity of the supply or demand for that good.

EXERCISE 6: Assume Congress is considering enacting a special tax to be paid by the manufacturers of cigarettes and other tobacco products. Congress hopes to accomplish two things with the tax: (1) increase federal tax revenues, and (2) reduce the amount people smoke. Discuss whether such a tax will achieve the desired results (either goals, or both). Illustrate with a graph showing the change in the equilibrium price-quantity combination.

4.4 Using Supply and Demand to Interpret the Meaning of Prices

An understanding of movements along either the supply or demand curve will provide some intuitive notion of what price measures or indicates under certain conditions. Taking the demand curve first, if a commodity is offered for sale at successively lower prices (for all of the units to be sold), people who decide to buy more of the commodity do so after taking into account what those dollars could buy in other available commodities. Thus, the dollars they give up in exchange for more commodity units at lower prices really represent the alternative goods and services they are willing and able to give up in exchange for more of the particular commodity in question. The now lower selling price is that which just induces consumers to buy more units of the commodity. This price, in effect, measures the opportunity cost only of the last units sold or those someone is just induced to buy since some units could have been sold at higher prices.

On the supply side, as price moves upward the quantity that suppliers are willing and able to offer for sale increases. Why is this the case? First, suppliers must acquire resources to produce the commodity they plan to offer for sale; these resources also have prices which these suppliers must pay. If these resources would otherwise have been employed or used to produce other, different commodities, then the value of these other commodities is what must be given up if the resources are used to produce more units of the commodity in question. As we have seen in the brief discussion of demand, the value of these other commodities is what people would have been willing and able to pay for them. Thus, the prices which must be paid for use of the additional resources reflect what people would have been willing and able to pay for the necessarily foregone alternative outputs.

So, the costs which must be covered by the rising prices required to call forth larger quantities supplied are, in fact, opportunity costs of foregone real benefits. And, as people give up more and more of these alternative goods, it is reasonable to expect that the value to them of the remaining units of alternative goods becomes greater (just the reverse of what happens if they acquire more and more of a particular commodity per unit time, in which case each additional unit used actually provides less addition to benefits than preceding units -- which may explain why more of a commodity can be sold only at lower prices).

Thus, we see in a rather intuitive fashion, that the prices established in markets for commodities in effect measure the opportunity cost of producing additional units, as well as the benefits realized from using additional units. This is the underlying rationale for using prices to quantify the benefits and costs

associated with a given government program.[1]

4.5 Total Revenues As a Conservative Estimate of "True" Total Benefits and Costs

We noticed in the discussion of the business firm's calculation of profit that total revenues and total costs were used; that is, prices multiplied by quantities. In this section, we will discuss these magnitudes in terms of how they provide satisfactory approximations to true benefits and costs. In effect, the business method involves estimating the benefits and costs of a particular project by estimating the total expenditures on the outputs of the project and on the inputs to a project, respectively. Businesses, of course, only take into account payments made to them for their products, and payments they must make to others for the required inputs.

If we look at the demand schedule of the curve we have constructed, we see that it is possible to represent the total expenditures on a commodity at a given price by the area of a rectangle as in Figure 4.11 below. The length of one side of

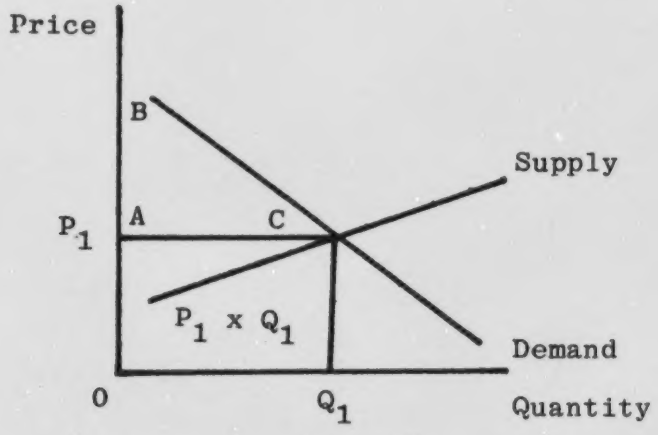


Figure 4.11: Total Expenditures on a Commodity

1. Later we shall see that certain conditions may cause a divergence between the observed prices and the opportunity costs they claim to measure. Thus, adjustments may be required to obtain more accurate estimates of the true opportunity costs associated with the use of resources in a project.

the rectangle represents the selling price; the length of the other side represents the amount of the commodity sold at that price. The area of the rectangle, of course, measures price times quantity, or total expenditures (revenues).

It should be apparent from this construction that estimates of prices at which output will be sold depend, among other things, upon the quantity placed on the market (and vice versa). An equally important, and perhaps slightly more subtle, observation is that the rectangle whose area represents total expenditures for a given commodity at a given price (given the demand curve) in fact represents a lower bound of the real benefits conferred, if we accept what people are willing and able to pay for different units as approximations to the real benefits received.

Why is this area the lower bound? Assuming that each unit of the commodity is sold at the same price as every other unit, as price is lowered to increase the amount that people will buy, the price must be lowered on all units sold in that time period. Thus, if each unit had been sold at a price which someone was willing and able to pay, more total revenue would have been collected. In fact, it is the total area under the demand curve, up to the number of units sold at the same price per unit, which more closely approximates the total of benefits received. The area of the triangle (ABC) under the demand curve, but above the rectangle $P_1 \times Q_1$, measures consumer surplus or benefits which people would have been willing and able to pay for, but did not have to.

We can see from the diagram in Figure 4.12 that the price differences $(P_1 - P)$ and $(P_2 - P)$ represent the difference between the actual selling price P for all units and the prices at which units Q_1 and Q_2 could have been sold if somehow it had been possible to extract from someone just what he was willing and able to pay for that unit. Thus, consumers who would have paid higher prices, but have to pay only the lower going price, receive a bargain -- the consumer surplus.

A government project which reduces the effective price of a good increases consumer surplus. For example, adding an additional lane to a highway can save time for commuters and truckers and thus lowers their travel costs. The benefit of higher consumption at lower prices is measured by the addition to consumer surplus. Figure 4.13 shows the addition to consumer surplus which might occur with a price change in two different demand situations.

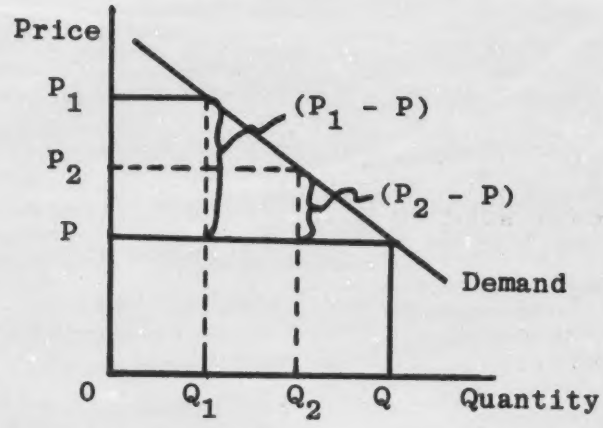


Figure 4.12: Consumer Surplus

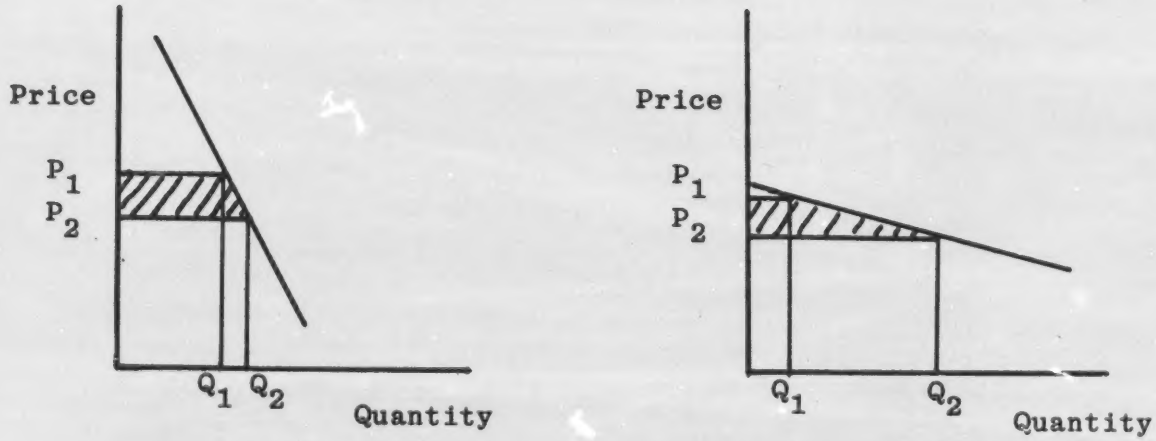


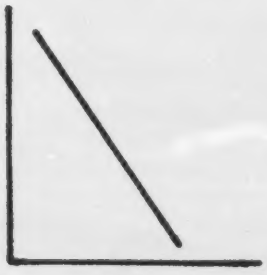
Figure 4.13: Changes in Consumer Surplus

Setting the actual prices and determining what quantities accompany them to obtain demand schedules for public programs is not an easy task. When people are already purchasing products similar to those which a government program will produce, this comparison is more direct and more easily accomplished. In many cases, however, people are not presently purchasing anything which closely resembles the government output, and then either a reasonable facsimile must be found or some other means of estimating worth employed. Depending on the total costs of the project and thus the opportunity cost which would be incurred if it were erroneously undertaken, it might be worth the expense of having special studies done to get a better idea of the real demand.

The next module discusses some of the peculiar aspects of government programs which frequently makes their benefits (and costs) particularly difficult to quantify.

EXERCISE 7: Which of the following demand situations would result in the largest change in consumer surplus if a government project resulted in a lower price? Sketch the change on each by indicating a hypothetical P_1 and P_2, Q_1 and Q_2.

(a)



(b)

(c)

MODULE V: CHALLENGES FOR VALUATION PRESENTED BY GOVERNMENT PROGRAMS

The special nature of government programs presents some challenges to the benefit-cost analyst. This module will discuss the aspects of government programs which can create temporary roadblocks at different points of a benefit-cost study and the options available for getting around these problems.

5.1 Market Failure: Government Takes Over

Why do we need a "public sector"? The reasons are many and diverse, but one of the most important ones is that the market mechanism cannot by itself accomplish all of society's economic goals. Left to operate freely, the market would not produce all of the needed goods and services in the "correct" quantities and combinations. Some goods which are very necessary to everyday life cannot be produced profitably. Public policy guides, corrects and supplements the market mechanism through laws and regulations, subsidies, tax incentives and provision of services, either directly or by contractual arrangements. Two broad cases of market failure (or in some cases, market inefficiency) have resulted in government program expenditures: externalities and public goods. Each of these will be defined and discussed in turn, but at this point it is important to recognize that government intervenes in this case because the market mechanism does not work for these classes of goods (or "bads," in the case of some externalities). Consequently, valuing benefits and costs by a system approximating "what the market" would produce is very difficult.

A. EXTERNALITIES

An externality is defined as a spillover or a by-product of a program, an activity or a production process. Externalities may be benefits or costs and thus, "good" or "bad" side effects of actions. The distinguishing feature of an externality is the inability or difficulty of obtaining payment for benefits or reimbursement for costs through the normal market mechanism (i.e., market failure).

In the last ten or fifteen years we have all been hearing about externalities in connection with the quality of the environment. Often externalities have been viewed as exceptions of small import; but in the case of environment, they become a pervasive problem. What kinds of effects are grouped under the heading of externalities? Air pollution can cause buildings (and people) to deteriorate more rapidly than they otherwise would. Water pollution kills fish, which in various ways reduces the benefits (food, recreation) provided to people by water resources. Salting of roads in winter may make driving safer, but it also causes automobiles to rust (and depreciate) more rapidly, and may increase salinity in soils and water tables to the point where additional harm may result.

The existence of externalities often is not recognized in a market transaction. Thus, it is often difficult to assign price valuations or even to determine the extent of such effects. These effects are termed externalities because they are imposed or occur outside of or external to the accepted or customary decision-making framework -- which, in the case of business, usually takes into account only those costs which must be paid for, or those benefits for which income is received. Unless compelled by laws or regulations, business enterprises usually will not include such external effects in their decisions. But, since externalities represent real benefits or costs, our benefit-cost guidelines for assessing government programs require that they be taken into account.

One important characteristic of externalities, which must be kept in mind in any attempt to include all costs or benefits in a benefit-cost study, is that they reduce or enhance the productive capability of some economic activity -- either the production of real goods and services, or the derivation of satisfaction from those goods and services. If the effect of externalities (e.g., costs) is recognized, restoring previously achieved levels of production or satisfaction will require the incurring of additional costs to counter the external effects. These costs can take the form of additional resources used to prevent the occurrence of externally imposed costs, or to avoid the consequences of externalities generated elsewhere. Or, the costs may take the form simply of reduced production, reduced satisfactions or both. Note that in the case of external costs, the side effect of one activity is an involuntarily received burden placed on some other activity -- an involuntary and nonreciprocal transfer from one party to another. This transfer occasions a reduction in productive capability (or in satisfactions obtained) which then may either be suffered, or partially or completely redressed, through corrective action by providing compensation to the injured party. Estimates of net benefits thus should be adjusted dowwards in taking account of associated external costs (or upwards, for external benefits).

However not all side effects are properly counted as externalities -- only those which affect positively or negatively the production of goods or services, or the obtaining of satisfactions therefrom. Take the following case: a highway project puts a new controlled-access high-speed route parallel to a stretch of old two-lane highway. Immediately, businesses such as gasoline stations and motels and curio shops along the two-lane highway experience a serious decline in sales. Simultaneously, similar businesses along the new route receive this business. How should this seeming externality be taken into account? The answer is, not at all -- at least not as a benefit or cost. The reason is that what occurs is simply a redistribution or transfer of income from one set of businesses to another, as a result of a substantial restructuring of factors affecting the demand for services rendered by the two sets. This redistribution is neither a benefit nor a cost -- it is simply a redistribution. There is no interference in a harmful or beneficial way with anyone's ability to produce anything -- only with his ability to sell it. What has happened is analogous to a shift of consumer purchases from corner drug stores to chain stores located at shopping malls -- a market phenomenon, not a production effect. This sort of effect is known as a "pecuniary externality" to distinguish such changes in the flow of money for purchases from changes in the processes of producing goods or deriving satisfaction from them. It is important to avoid including pecuniary externalities along with real external benefits or costs, even though it may often appear difficult to separate them. Such redistributive effects may be an important consideration in the overall appraisal of a program -- but they do not fall into the portion of the appraisal referred to as cost-benefit analysis.

The actual externalities of a particular project will depend directly upon the nature of the project being considered and upon the detailed characteristics of the activities being carried on within its "sphere of influence." Some externalities may not be identified simply because no one has as yet determined certain facts (e.g., what the actual by-products of a project will be, how and how far they may be transported -- by wind, water or by percolation through the soil). Or, because the relationships between known by-products and the various activities upon which they might have an impact (air pollutants on respiratory ailments or lung cancer, DDT on cancer or highway improvements on accidents) have not been determined. Note that some things which <u>look</u> like externalities (e.g., lung cancer from cigarette smoking) are not true externalities, even though there may be significant interference with people's ability to produce goods or derive satisfactions. This is because the effects occur to the decision-maker, the smoker, who presumably takes them into account -- however inadequately. (Of course, if one person's smoking adversely affects the health of those around him, this <u>is</u> an externality.)

B. PUBLIC GOODS

The second category of market failure which concerns us is public goods. The easiest way to understand the meaning of a "public" good is to consider first the distinguishing feature of a private good. To obtain an ordinary or "private" good, you must be both willing and able to pay for it. The "exclusion principle" states that if you cannot pay, you will be excluded from receiving the benefits of the good by the supplier. For example, you might like to own a Porsche, but you will not be able to have one if you are unable to meet the dealer's price. Private producers are able to stay in business because they can cover their costs by selling their product at a price which reflects those costs.

The "exclusion principle" either cannot be applied, or would be very difficult to apply, in the case of a special class of goods called public goods. The feature of a public good which distinguishes it from a private good and prevents the market from providing it, is that once the good is made available to even one person the good is generally available. Thus, the term "public" implies collective consumption rather than public provision. A person cannot easily be excluded from obtaining the benefits of the good for not paying. This situation leads to what is known as the "free-rider" problem where individuals take advantage of the good but do not want to pay for it. If the people of a city, state or the nation see that good as an important one, it can be provided by government and funded by taxes. Commonly cited examples of public goods include national defense and police protection.

Another characteristic of many public goods which makes determining a value difficult is nonrivalry. A good is nonrival when one person's enjoyment of the good or satisfaction is not diminished by another person's use. This is different from a rival private good which is generally used by one person or by one person at a time. If you eat a candy bar, you cannot give it to someone else to eat. Only one person at a time can use a sewing machine. However, any number of people can enjoy a sunset (a "public" good because of "collective" use) or visit a national park (up until the point of crowding). The fact that many goods are either completely nonrival (sunset) or have aspects of nonrivalry (police protection in a precinct) makes setting a "value" an arbitrary undertaking. We cannot really say how much the addition of one or two persons adds to the cost of a fully staffed precinct. Conversely, how much extra benefit is provided by the addition of recipients?

Some public goods (called "pure public goods") have aspects of both nonexclusiveness and nonrivalry. When national defense is provided over the area of the entire country, everyone in the country obtains the benefit (nonexclusive) without anyone else sacrificing the benefit (nonrivalry).

5.2 Further Problems

It is quite often difficult to obtain measures of value for project effects whose benefits are received directly by people -- where the final output of the project is what people directly benefit from or use. Thus, it is difficult to obtain benefit estimates for use of parks, recreational facilities or cleaner air. Such benefits are not quite so illusive as those mentioned as intangibles, but often it is difficult to estimate the benefits received since prices may not be charged for services. And when prices are charged they are not "market" prices, but simply arbitrarily set by government.

Externalities clearly represent real costs or benefits, and thus should be included in a comprehensive benefit-cost analysis of a public program. It is therefore necessary to obtain some dollar valuation of the costs or benefits involved. Sometimes, this may not be overly difficult: if one firm dumps sewage into a stream, which in turn forces a downstream firm or city to make substantial investments to reduce or eliminate the sewage prior to another use of the stream's water, these costs may be estimated fairly easily. Externalities may, of course, fall into the category of intangibles, such as aesthetic matters, and thus pose additional -- possibly insurmountable -- difficulties for the obtaining of quantitative estimates. In general, it is easier to estimate benefits (cost savings) of any sort, including externalities, when the effect is on a production process, than when it impinges directly on the final consumption activities.

However, there are circumstances in which it may be extremely difficult to obtain satisfactory estimates of the value of a program's output. Either of the following examples provides a case in point: a program to reduce air pollution by a certain amount, or a program to reduce crime in an area by some amount. In each case, we seek some value to be assigned to the benefits of such programs. In both examples, the benefits provided take the form of reduced probability or risk of injury to people -- injury to health or to self. (Reduction in harm to property in both cases may be more easily estimated. But to get the full value of the benefits, the value to people of reduced risk of injury to themselves must be included.)

The "free-rider" phenomenon of public goods suggests problems for obtaining value estimates. Individuals have no incentive to reveal to government how highly they value public services. Suppose we were to survey people to determine what the value to them would be of reduced risks associated with pollution or crime control programs. Suppose further that people believed that a) the price they paid for the program would be affected by their response, and b) their response would minimally affect the chances that the program would be initiated since their own contribution

would be a small part of the total program cost. A survey such as this would elicit systematic underevaluations of the benefits received by each person (even if they have accurate information on the effects of the program and how those effects will affect them, unless people could feel certain that everyone was revealing his or her preference). In practice, the political system allows representatives to determine what mix of services voters desire, but this does not help us with pricing program output.

The art of obtaining more accurate valuations for goods of this sort is in a rudimentary stage. One technique is to examine situations in which people may have paid, under conditions which did not permit a "free rider," for similar reductions in risk to self. Observing people's actions, such as attendance patterns at parks, is another means of ferreting out their preferences.

EXERCISE 8: For each of the following situations, list what you consider to be important externalities (costs or benefits) as defined in Section A. Since the situations are not completely described, your list will probably contain hypothetical items, such as: "If _____ occurs, and _____ (an activity) is nearby, then _____ (in effect) is likely to occur." Be sure to label each externality as a benefit or cost. Also, include any benefits which you feel might be characterized as public goods, with an explanation of why you think so.

(a) A farmer sets up a series of beehives near his neighbor's property; the neighbor grows apples.

(b) A backpacker takes along his favorite foods, packed in cans and foil, which he plans to prepare over open wood fires.

(c) A regional recycling center is set up to separate, clean and concentrate waste materials such as metal cans, glass containers and newspapers.

(d) A high-speed intercity passenger train is put into service, connecting most metropolitan centers in the northeastern U.S.

MODULE VI: THE COMPARISON OF COSTS AND BENEFITS WHICH OCCUR AT DIFFERENT TIMES

This section will introduce you to a method which is widely used in economics and business to allow expenditures and returns which occur at different points in time to be compared. This procedure is called discounting.

6.1 The Idea of a Time Value of Money

Proponents of government projects sometimes make claims such as: "This program will cost only $20 million dollars, but will mean $50 million dollars in benefits over the life of the project." Is this project worth undertaking?

The answer to this question will depend largely upon just how long "the life of the project" is. A return of $30 million in benefits after the initial cost of $10 million is recovered might be excellent if all of the benefits were received within five years. On the other hand, if the benefits will be received after 30 years or 50 years, the return might not justify the cost.

Why is this distinction made between benefits which occur in the near future and benefits which are not realized for many years? The major reason we are concerned about the differences is because money has time value and individuals have time preferences. This means that most people would rather have cash in their hands today than a promise of cash in the future. Inflation, risk, convenience and flexibility in decision making are all reasons why people believe money is more valuable today than later. If you were given the choice of receiving $200 today or waiting one year to receive $200, you, like most people, would prefer to receive the money now. Conversely, if you owed $200 and had a choice of paying today or a year from today you'd be likely to wait.

An example may help you to understand the importance of the time value of money in decision making. Suppose a local ski shop advertises a big sale on skis in March. You have been considering buying skis, but after all, it is March and there are other things you might do with the money. How much would the ski shop have to reduce the price of the skis to induce you to buy now and wait almost a year to obtain the first benefits from your investment?

The answer to this question will, of course, involve many factors, including your personal evaluation of the opportunity cost that will be incurred by choosing the skis over an alternative use of the money. In a common situation, the amount of the discount on the skis would have to at least equal the amount of interest you could earn by putting your money in the bank until next fall's "pre-season" sales. Assume a simple situation where the interest rate on regular savings accounts is 6% paid once at the end of the year. We can use the compound interest formula to see how much our investment will yield in a year:

$$P(1.0 + r)^n$$

where: P = Principle

r = rate of interest

n = number of interest periods

Substituting $100 into the formula we obtain:

$$100(1.0 = .06)^1 = \$106$$

Thus, $100 invested today will be worth $106 in one year. So if you have $100 to spend, the merchant would have to reduce the skis by at least $6 to make the discount on the skis equal to the interest which could be earned.

6.2 The Discounting Procedure

Most choice situations are more complicated than that of the foregoing example. Government projects particularly frequently have benefits which occur over many years. Assume a situation where a choice must be made between two projects with equal costs but considerably different patterns of benefits over the years (also called benefit streams) as shown in Table 6.1 on the following page.

Table 6.1: Comparing Two Hypothetical Projects

PROJECT	COSTS	BENEFITS					
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
A	$1000	$100	$150	$400	$300	$200	0
B	$1000	0	0	$500	$300	$200	$200

Which project is a good investment, that is, where benefits are equal or greater than costs? Both benefit streams total $1,200. However, since the costs occur right away and some benefits are delayed by as much as six years, the benefits cannot simply be summed and compared to the cost. Since this type of situation where costs and benefits do not occur at the same time is frequently encountered, a procedure called discounting is used to translate benefits or costs which occur in the future to a present value so we may compare them. Discounted present value is the current amount of money which is equivalent to a specified amount of money to be received (benefit) or paid (cost) at some specific future time.

The formula for discounted present value is simply the reciprocal of the compound interest formula. When using compound interest, as in the example of banking our money instead of buying skis, we multiply the principle amount invested by 1.0 plus the rate of interest raised to the power of the number of periods the money is invested. Conversely, when discounting, we want to determine how much a benefit or cost occurring in the future is worth today. We do this by dividing the amount of the benefit or cost by 1.0 plus the discount rate (which is similar to the idea of an interest rate) raised to the power of the number of years until the cost or benefit occurs.

The discounted present value formula is shown on the following page.

$$DPV = \frac{B \text{ or } C}{(1.0+r)^n}$$

Where: DPV = Discounted Present Value
B = Amount of Benefits
C = Amount of Cost
r = Discount of Rate
n = Year Benefit or Cost Occurs

Now we may apply discounted present value to our example of the hypothetical government project to see which project is the better investment. Table 6.1 shows that both projects have an initial cost of $1,000 occurring at each project's outset. Should these costs be discounted? The answer is "No." Since the costs are incurred right away, the present value of the cost is equal to the stated amount.

The benefits of both projects occur over time. Let us consider Project A first, using a discount rate equal to 5%.

Table 6.2: Application of Discounted Present Value Formula to Project A

Benefit Year (n)	Amount of Benefit (B)	Application of DPV Formula (r = .05)	=	Discounted Present Value (DPV)
1	$100	$\frac{100}{(1.05)^1}$	=	95.24
2	150	$\frac{150}{(1.05)^2}$	=	135.99
3	400	$\frac{400}{(1.05)^3}$	=	345.42
4	300	$\frac{300}{(1.05)^4}$	=	246.71
5	250	$\frac{250}{(1.05)^5}$	=	195.77
6	0	$\frac{0}{(1.05)^6}$	=	0

In order to determine whether the benefits of this project are greater than its costs, we must sum the present value of each year's benefit:

Year 1	$ 95.24
Year 2	135.99
Year 3	345.42
Year 4	246.71
Year 5	195.77
Year 6	0
Total Present Value (PV) of Benefits:	$1,910.13

Thus, the total present value of the benefits of Project A, $1,019.13, exceeds the cost of $1,000 by $19.13. Applying the foundamental rule that benefits must at least equal costs ($B - C \geq 0$) tells us that Project A is a good investment.

We must now consider Project B to determine whether it is a better or worse investment than Project A. Table 6.3 shows the appreciation of the discounted present value formula to Project B.

Table 6.3: Application of Discounted Present Value Formula to Project B

Benefit Year (n)	Amount of Benefit (B)	Application of DPV Formula (r = .05)	=	Discounted Present Value (DPV)
1	$ 0	$\frac{0}{(1.05)^1}$	=	0
2	0	$\frac{0}{(1.05)^2}$	=	0
3	500	$\frac{500}{(1.05)^3}$	=	431.78
4	300	$\frac{300}{(1.05)^4}$	=	246.71
5	200	$\frac{200}{(1.05)^5}$	=	156.61
6	200	$\frac{200}{(1.05)^6}$	=	149.14

Again, to determine the total present value of the benefit stream it is necessary to sum the present values of the individual year's benefits:

Year 1	$ 0
Year 2	0
Year 3	431.78
Year 4	246.71
Year 5	156.61
Year 6	149.14
Total Present Value (PV)	$984.24

When the discounted present value of Project B's benefits is compared to the costs, the costs are seen to exceed the benefits.

Thus, in this choice situation it is obvious that Project A should be selected. It is important to note that while Project A and Project B offer the same benefits of $1,200 when the time value is not considered, Project B's benefits do not begin accruing until the third year. This postponement of benefits causes the project to be an unacceptable investment when the present value of the benefits is obtained by discounting.

EXERCISE 9:

A. Calculate the present value of $10,000 received at the end of year 5, discounted at 5%:

B. Would a project which yielded benefits of $1,500 at the end of each of six consecutive years, discounted at 5%, be a better or worse investment than the return indicated in Part A ($10,000 at the end of five years, discounted at 5%)?

6.3 Choosing the Discount Rate

The foregoing section illustrates an important rule of thumb about the time value of benefits: the longer you have to wait for your return the less it will be worth to you. On the other hand, costs which can be pushed off into the future reduce the present value of the required outlay.

Table 6.4 illustrates the impact which different discount rates can have on a benefit or cost of $1,000 occurring at various possible points in time.

Table 6.4: Impact of Time and Discount Rate on Present Value

		Discount Rate				
		5%	7%	10%	12%	15%
Year of Return or Outlay	5	784	713	621	567	497
	10	614	508	386	322	247
	15	481	362	239	183	123
	20	377	258	149	104	61

These figures illustrate that the choice of what discount rate to use in a benefit-cost analysis is a crucial decision. How can a "good" rate be determined?

There is no simple answer to the question of which discount rate should be used. It is apparent, however, that since the discount rate can make the difference between a project's acceptance or rejection, it must be chosen with care. A discount rate which is too low may result in a project being undertaken which should not be. It should be kept in mind that the decision to remove resources from the private sector to fund a government project incurs the opportunity cost of the use it might have been put to in other hands. Thus, a wasteful project incurs a particularly high opportunity cost.

The choice of a discount rate may therefore be based upon an estimate of the rate of return the resources would otherwise provide in the private sector. The use of opportunity cost as the criteria for determining the discount rate allows projects to be undertaken which yield benefits greater than the resources could earn in the private sector and rejects projects which do not.

Perhaps not too surprisingly, this method of determining the discount rate is not easy to use in actual practice. Rates of return in the private sector vary from one investment to another. To choose the correct "opportunity cost" rate of return, the government analyst would need to know the particular private sector project which was being displaced. Obviously, this is an impossible task since public sector projects, which are funded by taxation and borrowing, may (and do) displace business investment, consumer spending and saving as well as alternative government projects.

To assist us in choosing a reasonable rate, we may turn to information provided by markets, inquiring whether there is some price (determined by supply and demand as in our earlier discussion) which effectively measures the price at which some people are willing to give up present benefits (consumption) and at which others are willing to buy funds to make investments to provide future benefit streams (consumption). We find such a price in the interest rate, the rate (or price) at which some people loan funds -- which they could alternatively have spent on current benefits -- and the rate (or price paid) at which other people will borrow funds from lenders to undertake investment projects. The interest paid, of course, is a cost of obtaining the funds, and must be paid from the returns of the investment. The returns to these (private business) investment projects must come from sales of goods and services over some future time period.

Intuitively, the participants on both sides of the market for loanable funds -- the supply and demand sides -- are engaged in their own individual discounting calculations which take into account what they must give up for what they wish to obtain in the future. Suppliers of funds are comparing what they must surrender in terms of present satisfactions to the additional purchasing power they will receive in the future (the interest they earn on their loaned money). If suppliers are willing to give up some current satisfactions in anticipation of future benefits, they must have arrived at some present value of these future benefits equal to the present cost (satisfactions foregone) of loaning their money. Of course, persons who discount more heavily will require more interest payment to induce them to give up their money. On the other side of the market, borrowers must be going through similar calculations which permit comparisons of future benefits with a present commitment to pay the promised interest rate on the money they borrow, and the obligation to repay the amount borrowed.

The arrival of borrowers and lenders at a specific interest rate satisfactory to all occurs through a simple demand and supply situation, with the intersection of the curves determining the equilibrium interest rate. Figure 6.1 on the following page shows a hypothetical market for funds.

The supply line represents the total amount of money which lenders will make available to borrowers at any given interest rate. The lenders are actually individual investors and savers. Not surprisingly, the amount of money they will be induced to invest (and thereby forego the convenience of holding the cash) rises as the rate of interest (r) rises. Borrowers, on the other hand, are less willing to take advantage of the additional funds as interest rises. As with our general supply and demand model, market forces prevail and an equilibrium point is reached, giving the market rate of interest.

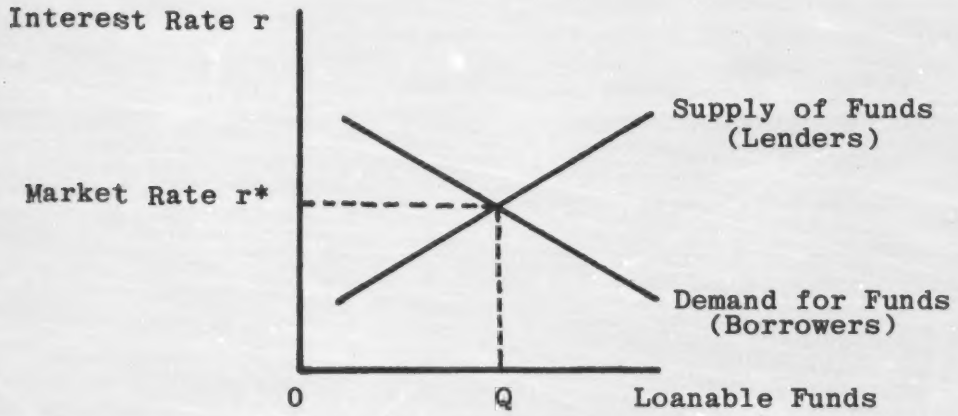


Figure 6.1: Supply and Demand for Loanable Funds

The rationale for using the market rate of interest as the discount rate for government programs hinges on the fact that undertaking public sector projects requires the transfer of resources from private uses to public uses. We know from our discussion on how these markets operate that potential borrowers of funds in the private sector will not borrow unless they can earn enough through their investments to at least pay the interest on the funds they borrow (after they subtract from their estimated future revenues all the costs of producing and selling their goods or services, including repayment of the original amount borrowed). If the government or one of its agencies undertakes a program in which the present value of the future benefit stream, discounted using the market rate of interest, is not at least equal to the present investment costs, then we know that these resources could have been put to better use in the private sector.

EXERCISE 10:

A. Assume that it will cost you $5,000 to insulate your new home. If the insulation lasts ten years, will a saved heating cost of $600 per year, discounted at 7%, make this a good investment? Will a yearly return of $700, discounted at 7%, make this a good investment?

B. Is the following government program worth undertaking?

Initial capital or start-up costs:	$5,000,000	
Operating and maintaining costs:	100,000	per year for five-year program
Benefits:	1,200,000	in each of five years of program life

(Use a discount rate of 10%.)

6.4 Sensitivity Analysis

It should be obvious to you by now that there is a great deal of individual discretion exercised in setting up and conducting a benefit-cost analysis. The accuracy of the final comparison of benefits to costs depends on many small decisions during the study. Accurate estimates of capital and operating costs, number of recipients of benefits, benefit value and choice of the discount rate are all parameters which determine what the final line-up of benefits and costs will look like. Variations in any or all of these parameters can easily change the entire picture, as we have just seen with discounting.

A carefully conducted benefit-cost study must include an analysis of how the final decision might be affected by a change in one or more of the underlying assumptions. This determination of how sensitive the decision is to change in the various parameters is called sensitivity analysis. Sensitivity analysis generally involves varying the estimated values of costs, benefits and particularly the discount rate to see how much "give" there is before the project benefits no longer exceed the costs. If application of a discount rate of 8% gives a present value of benefits which exceeds the present value of costs, but a discount rate of 8.5% does not, the decision is obviously very sensitive to the discount rate.

Sensitivity analysis demonstrates to decision-makers which of the assumptions are critical in affecting the worth of a specific program, and provides concrete discussion points. Benefit-cost decisions which hold up under sensitivity analysis provide more satisfactory information on which to base decisions than ones which fluctuate greatly with slight variations in the values of the crucial parameters. In general, a benefit-cost study which does not present some sensitivity results is likely to be advanced only as a stalking-horse, and deserves careful scrutiny.

EXERCISE 11: A benefit-cost study of a proposed project indicates that benefits will amount to $1,000 per year for five years. The total project cost is estimated at $2,700, to be paid at the project's outset.

A. On the next page, using discount rates of 7%, 8% and 9%, determine whether the project is a good investment at each of these various rates.

B. Suppose the actual cost of the project turns out to be $3,500, but the amount can be paid in three installments: $1,000 right away, $1,500 at the end of the first year and $1,000 at the end of the second year. If the discount rate (r) is 7%, is this project worth undertaking? What if the discount rate is 8%?

MODULE VII: FURTHER CONSIDERATIONS

The following hypothetical study may help to present some additional aspects of benefit-cost analysis:

7.1 The Study

The Bureau of Reclamation (which, along with the Army Corps of Engineers, is in the business of building dams) has conducted a study to determine whether a dam should be constructed at a particular site on the Colorado River. Construction of dams along the river represents one part of the implementation of federal and state policies designed to develop the water resources of the American Southwest, and is the special responsibility of the Bureau.

Since the language of the legislation directing the development of water resources requires providing the maximum possible benefits to the area, the Bureau called in a team of analysts to figure out whether the benefits the region would receive from the particular dam project would be worthy of the cost of constructing it.

The report was finally submitted, and it showed that the dam would provide an estimated two billion dollars in benefits during its lifespan for an initial investment of $500 million. This looked like a good deal since the ratio of benefits to costs is 4:1, and it was decided to proceed with construction of the dam.

Construction of the dam was delayed, however, because a local group of concerned citizens obtained a court injunction against beginning the project until a more thorough review of the supporting study could be made. Included in the evidence submitted by the citizens' group were the following observations:

1. Fully one-half of the two billion dollars in benefits attributed to the dam will not be realized until 10 to 20 years

after the dam is completed; yet these future returns are compared directly with the immediate investment cost of $500 million.

2. The dam represents a multipurpose project, providing benefits in the form of increased agricultural output by irrigation, recreational benefits from the reservoir, hydroelectric power output and flood control. However, nowhere in the report is there any mention of the facts that, in some sections, increased salinity of the soil due to irrigation will prevent the growing of certain valuable crops, or that a section of the river used extensively for canoe and raft trips will no longer be useable for these purposes.

3. The dam's benefits include future sales of sugar beets. The report shows that the value of this sugar beet output is calculated at current prices, even though beet prices have been declining steadily at 5% per year. Further, increased sugar beet production attributed to the dam is expected to be about 50% of the amount currently on the market.

4. One of the benefit elements, increased corn production due to the dam's irrigation system, is used entirely to feed beef cattle fattened in the area. Yet, both increased corn output and increased beef output are included among the benefits.

5. The benefits provided by the dam include hydroelectric power, valued at .09 dollars per kwhr. The total benefits from this source are calculated to be the estimated number of kilowatt hours produced each year, multiplied by the selling price. The citizens' group notes that residents and businesses of the region are currently obtaining this amount of power from fossil fuels, at a cost of .12 dollars per kwhr. Further, the power plant will be able to sell its output at .09 only because the funds used to finance the dam will be obtained at a rate of interest below that which must be paid by private companies through the use of tax-free bonds.

6. The Bureau has estimated that 5,000 new jobs will be created during the construction period, and adds in benefits amounting to this number of jobs multiplied by the annual wage. The citizens' group points out that:

   a) the jobs are in fact a cost of the dam, not a benefit (adding them in effectively double-counts benefits already measured as the value of outputs produced by the labor) as embodied in the dam.
   b) not all of the jobs are new jobs anyway.
   c) if the jobs are to be figured in as costs, these calculations should recognize that some of the workers would have been unemployed if the dam were not built (and

possibly collecting unemployment benefits), and consequently the true costs of employing them are much less than the going wage. (This adjustment would lower the cost of constructing the dam.)

7. The citizens observed that the analysts' study attributed to the dam savings in property loss from floods equal to the entire amount lost on the average per year (using the total losses for the last ten years for the estimate); however, fully one-half of the usual losses already are prevented by an improved dike system recently put in place.

8. Finally, according to the citizens' complaint, the dam requires that an entire tribe of Indians must be removed from their ancestral lands; this is, in fact, included as a cost in the analysts' report, but only insofar as the amount required to physically transport the Indians to a new government reservation and comparable housing.

9. As a parting shot, the citizens' group notes that the Bureau's estimates have assumed that the dam will operate at full capacity over the next 50 years, with no allowance for various contingencies, including the possibility that it might fail completely and wreak havoc in excess of all anticipated future benefits.

Table 7.1 on the following page relates the citizens' comments to actual aspects of benefit-cost analysis. Some of these will be familiar to you already and others will be presented in the remainder of this module.

7.2 Selection and Adjustment of Prices: Shadow Pricing

The citizens' third objection to the cost-benefit analysis performed focuses on which prices have been used to value the sugar beet output. Apparently, the benefits attributed to the dam by the Bureau have been augmented by using current prices for sugar beets, even though these prices are observed during what appears to be a long-term downward trend (of course, they may represent the "bottom" of the trend). If the prices employed had been observed at the beginning of what later proved to be a downward trend, there is obviously some basis for using an adjusted price; e.g., an average over the last three years, which would be lower than the price observed at the beginning of a downward series.

A second problem in selection and adjustment of prices used to value output is introduced due to the fact that the additional sugar beet production attributed to the dam is a considerable

Table 7.1: Putting the Citizens' Criticisms into the Benefit-Cost Framework

Citizens' Points	Aspects of Benefit-Cost Analysis
1. Future benefits are not compared with present costs.	1. Discounting and selection of a discount rate.
2. Not all consequences of the dam are included; omitted in particular are effects which adversely affect production in other areas even though these effects are not recognized in customary ways.	2. Externalities.
3. Valuation of future outputs does not take into account future demand and supply for the output conditions (particularly the increased supply due to the dam).	3. Shadow pricing.
4. Values are assigned both to an intermediate product and a final product.	4. Double-counting.
5. The full amount of expenditures on hydroelectric power are included.	5. Benefits valued as net savings.
6. Costs (jobs) are included as benefits, using the going wage.	6. Shadow wages.
7. Benefits are attributed to the dam incorrectly.	7. Incremental benefits only or net savings caused by the dam should be attributed to it.
8. The dislocation of the Indians and their loss is inadequately accounted for.	8. Multiple objectives, distribution and other non-quantifiable considerations.

proportion of the amount currently supplied to the market (the supply to which the observed prices apply). Even if prices could safely be assumed to remain stable over the period for which the valuation is made, the effect of dumping such a sizeable increase in output on the market should be to reduce prices significantly (unless equally significant shifts occur in the demand of the market -- see Figure 7.1 below). In any situation in which the output from a government program represents a substantial change in the supply of a commodity, the resulting changes in prices should be taken into account by adjusting currently observed prices.

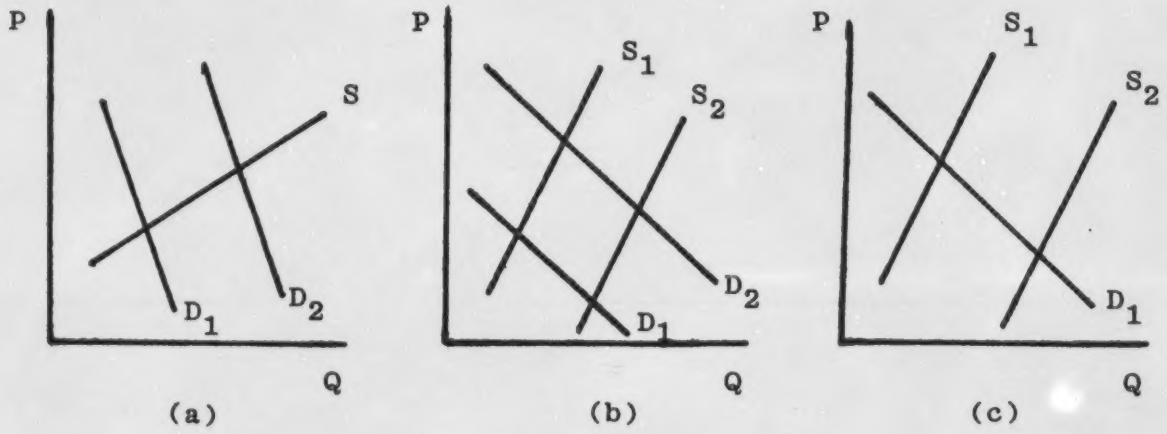


Figure 7.1: Supply/Demand Diagrams

A quick examination of the three supply/demand diagrams in Figure 7.1 will make the nature of the problem apparent. In diagram (a), where there is no appreciable change in supply but increased demand over time (due to increases in population, income or preferences), prices rise. In diagram (b), an offsetting shift in supply reduces price to a level below what it would be in the first example. Finally, in diagram (c), where demand does not shift, an increase in supply brings about an appreciable decrease in price. Using the previous prices to evaluate the new, increased level of output results in an overestimate of the actual price times quantity measure of benefits. This is shown in Figure 7.2 on the following page.

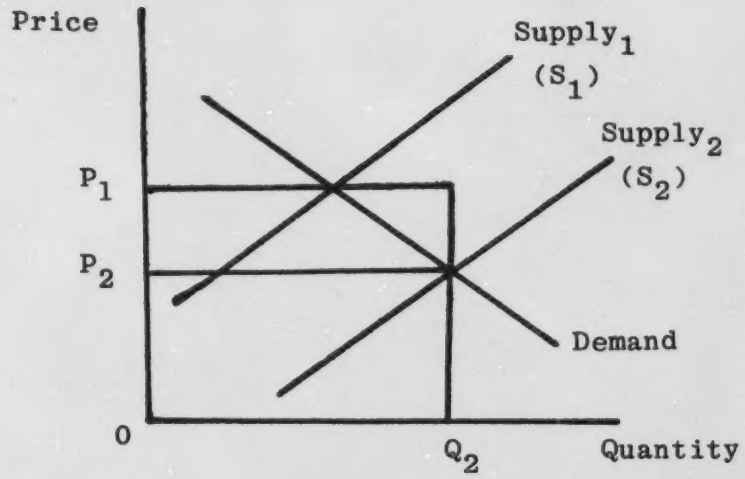


Figure 7.2: Overestimation of Actual Price

Use of market prices to evaluate the outputs of public investment programs will require some forecast of the future pattern of output prices. This in turn will require some estimates of movements in supply and demand over the life of the project. This is not an easily overcome problem, since the actual future movements will depend upon many eventualities which are difficult to predict with any accuracy or reliability.

However, if we know from the nature of the project that output of a commodity will increase significantly, this should be taken into account. For example, if under projected demand conditions each 10% addition to the quantity supplied is estimated to result in a 3% decrease in price, then this estimated impact on market prices should be considered. One way to do this is simply to average the "before" and "after" prices.

Suppose that the current market price is $10 per unit, and that our best estimate of long-term future price, including the impact of additional output, is $7.50. Which price should we use? The $7.50 price is somewhat low, since many units of output could in fact be sold at $10, or at prices between $10 and $7.50. (One quick solution is to use the simple average of the two prices, or $8.75.)

7.3 Observed Prices and Shadow Prices

The effects of government activity can be felt in markets. thus affecting observed prices for outputs, before a program goes into effect as well as after. In fact, governmental influences on prices through taxes and subsidies are extremely pervasive, and often require adjustments in benefit-cost analysis. Suppose that the price for sugar beets includes the effects of a government price-support program. However the program is implemented, if it is effective, the price of sugar beets will be higher than the "true" market price without the government's influence. Since we are relying on market -- supply and demand -- prices to measure benefits and costs and not on prices as they reflect government attempts to influence market prices, it is important that observed prices be adjusted to more closely approximate the market prices which would be observed if they were not influenced by other government actions.

The true market prices we seek are referred to as "shadow" prices, the prices which reflect relative scarcities or opportunity costs which lurk behind the observed prices. Clearly, what must be done is to estimate the effect on prices of a government price-support program, and subtract this amount from the observed prices. The methods for making these estimates and for obtaining shadow prices are rather technical. However, it is often obvious that the effects of government programs are being included in the observed prices, even though the exact magnitude of the influence is not easily calculated. When the effects are likely to be large, they must be taken into account.

Prices for sugar beets were artificially high because they were influenced by a government price-support program. In the case of electrical power, prices at which power output is sold are also affected by government -- this time they are lower due to an implicit subsidy. Since the subsidy has the effect of lowering prices below the levels which would prevail in markets without this influence, an adjustment to the true or shadow price is called for.

7.4 Shadow Prices: Nongovernmental Influence

The prices available for benefit-cost analysis may require adjustment to purge effects other than those produced by government activity. In principle, any influence which distorts prices so that they do not reflect true opportunity costs should be taken into account in valuing outputs or inputs.

Monopoly represents one form of nongovernmental influence on

prices which causes them to deviate from accurate opportunity cost indicators. Monopoly refers to the market situation in which there is only one seller of a product. While there are few cases of pure monopoly, it may often be the case that several large sellers in a given market may get together to act like a monopolist, in order to increase their profits. In either case, the effect is the same: the seller or sellers restrict output to obtain higher prices -- prices often much in excess of the full economic costs of production.

Of course, it may not be easy to determine the extent of monopoly-like influence on observed prices. However, if the market for the output of a proposed government program is easily recognized as containing some element of monopoly (e.g., a few large sellers, very stable prices, etc.), there is a good chance that currently available prices are affected by such organization and should be adjusted downwards. For example, if electric power is to be sold in an area previously dominated by a single utility company, and, even though it has been regulated, the company shows extraordinary profits over the preceding ten years, prices at which the government-supplied power is valued should be reduced below prevailing prices to reflect the extraordinary profit element in the existing price structure.

EXERCISE 12: Assume that the government has imposed a ceiling price on gasoline and heating fuel oil, to prevent the market price from rising to levels which it believes would impose a heavy financial burden on users. (Using a supply-demand diagram, illustrate a ceiling price below the market equilibrium price.) If a benefit-cost analysis is performed to evaluate a new pipeline, would the ceiling price be appropriately used to value additional gasoline and fuel oil outputs? Why or why not?

7.5 Double-Counting

The citizens' group's fourth objection centers around the benefits associated with the increased corn production which the dam causes. The issue behind this objection is rather straightforward, although given the nature of actual benefit-cost reports as they are presented for examination, handling it may require some disentangling of various benefit and cost accounts. The citizens' objection in this case directs us to a pitfall to be avoided, rather than to a new positive guideline or technique.

If the analysts include both the market value of the corn and the market value of the beef which is fed on the corn, they will have included the value of the corn twice, since its cost is also covered in the price of beef (which covers the cost of producing the beef, including feed). To count the corn both times would be analogous to arriving at the total value of an automobile by adding together the price of the vehicle at the dealer's lot, with the price of the steel, rubber, glass, starter, generator, battery, etc. Clearly, the materials and labor which went into the car are covered already in the price of the car.

Unless the benefit and cost accounts in a given report are clearly labeled and sufficiently detailed, it may be very difficult to determine (without extensive cross-examination of those who prepared the report) whether some intermediate outputs have been valued twice -- once separately and once as embodied in a final output.

Double-counting can creep into a benefit-cost account in a second way. Occasionally, an account will show two categories of benefit: reduced costs of production for some commodity, and increased profits for the firm selling the commodity. Since profits are defined to be the difference between revenues and costs, once we have counted the cost-lowering effect of the project, we have captured the increased profit effect as well.

EXERCISE 13: Suppose that a new four-lane highway is constructed to replace an older two-lane highway over the same route. A benefit-cost account for the new four-lane road shows saved travel time for truckers and for private vehicles, and includes the value of increased gasoline sales and increased profits to trucking firms. Is there some double-counting in this account, and if so, where? (Use additional space at top of next page.)

7.6 Benefits Valued As Net Savings

In their fifth point, the citizens argue that counting the total benefits due to power production and sales as the number of units of power produced multiplied by the selling price per unit is a gross overestimate of the benefits provided by the power. An alternative source of power was previously available and was replaced by hydroelectric power because it was cheaper, providing savings in power costs over the alternative power source. It is the savings in energy costs over the costs of the next best alternative which constitute the benefits attributable to the dam.

EXERCISE 14: What type of benefit would you attribute to supersonic air transport?

7.7 Jobs As Costs Not Benefits: Unemployment and the Opportunity Cost of Labor -- Shadow Wages

Part of the objection leveled by the citizens' group in their sixth point is related to the undesirable practice of double-counting discussed on page 61. While there is no question that jobs are beneficial to an area or to the country, the value of these jobs -- which are a cost of the project, not a benefit -- is already covered in the construction bill for labor and materials. The benefit of having people employed is what they produce; that is, the benefits attributed to the dam, which can be counted separately.

The second part of this point is less direct; it involves imputing a cost to labor which reflects the true opportunity cost of employing that labor. Suppose that there is considerable unemployment in an area and that, in fact, many men and women are willing and able to do dam construction at wages far below the customary wage for that type of work. Suppose in addition that these people are presently living on unemployment compensation payments, social security benefits and food stamps. All of these means of support require direct or indirect payments from the public treasury. Having these people employed avoids incurring these costs. Further, since there is nothing given up (they are not gainfully employed elsewhere) when they go to work for the construction project, they are not sacrificing anything. Perhaps most importantly, the total pool of labor available to work is larger than usual so that other projects need not be foregone due to lack of manpower. Thus, the going market wage very likely overstates to a substantial degree the opportunity cost of labor hired to work on the dam. A downward adjustment is called for. Again, it may be difficult to arrive at the amount of this adjustment, but some care should be taken to obtain a true or shadow wage reflecting the net opportunity cost of labor.

EXERCISE 15; Is the opportunity cost of using labor for a government project likely to be higher or lower than customary during a recession? Why?

7.8 Incremental Benefits Only

The relevant consideration here is that only those benefits or net savings attributable to the dam should be included. While this may appear to be an easily avoided pitfall, it may not always be so. Sometimes, things which appear to be benefits attributable to a project may be due to the fact that large numbers of people, have, for some reason, behaved in a way which reduces losses previously experienced by them. This alteration in behavior patterns may be discovered only after painstaking attention to other factors which may have been influential, and may possibly require some statistical work designed to separate out the relative importance of various contributing factors.

For example, a city government may institute a set of stiff air pollution regulations, at considerable cost to the industries involved. It may be predicted that, on the basis of the experience in a similar metropolitan area, such regulatory standards will reduce deaths during the summer months by 27% and the number of respiratory ailments requiring hospitalization by 75%. However, neither city may have noticed that over the same period during which the standards were being put in effect, the high risk population for such ailments had (on an individual basis but in considerable numbers) taken steps which would have brought about the decline predicted (stayed indoors during the critical periods, used more air conditioning, vacationed away from the city, or even relocated permanently). To be sure, some benefits would probably result from the standards themselves (e.g., reducing the long-term cumulative effects on people which would make them more susceptible to respiratory ailments in the future), but these must be separated from those brought about in other ways.

EXERCISE 16:

A. Suppose that the federal government has mandated that all automobiles sold after a specific date be equipped with seat belts. Over the three years following this date, the National Safety Council records 20% fewer deaths and 40% fewer injuries resulting from automobile accidents. Should these lower statistics be attributable fully to seat belt use? List possible additional contributing factors.

B. A study determines that a new drug has significantly reduced the frequency of heart attacks in the 45-50 age bracket. On the basis of 80% coverage of the population at risk in this group, the estimate is made that 10,000 deaths at this age due to heart attack could be prevented by a widespread drug program. Disregarding the problem of how these lives are to be valued (a tricky, unsettled matter, conceptually and practically, still debated in the professional benefit-cost literature), but assuming an average life span of 75 years, the report goes on to attribute an annual savings of 250,000 man-years to the drug program. What else would you like to know before you accepted the estimate of savings in lives attributed to the drug program?

7.9 Multiple Objectives, Distribution and Other Nonquantifiable Considerations

Consequences to the Indians from construction of the dam represent, at best, a relatively intractable problem to the benefit-cost

analyst. Very important but not easily quantifiable benefits or costs may be associated with particular programs. What value is to be placed upon the Indians' ancestral home, places or worship or general patterns of life? We might try to discover what the Indians would be willing to pay to retain their homes (or what sort of a fight they would mount) to obtain an estimate of the loss to be compensated, but since both measures will be significantly affected by the Indians' poverty, they may not be acceptable estimates. Of course, it might be suggested that the Indians be fully compensated for their loss by providing comparable housing and an annual per capital income at least equal to what they earned on their homeland. However, a certain number of dollars received on the dole is not necessarily comparable to earning the same amount pursuing traditional occupations.

The example of the Indians introduces a second type of problem which is not readily handled within the economic or business framework of benefit-cost analysis -- that of distribution or equitable treatment. In many cases, the beneficiaries of a specific program are not the same people who bear the costs, compensated or not. A public investment in a dam or a highway may provide enormous benefits -- both short- and long-term -- to a large group of people, but totally disrupt the lives of others.

Although these difficulties are not easily resolved, and not at all with the techniques available to the benefit-cost analyst, they are important to keep in mind in reviewing a particular benefit-cost study, or appraising its implications for public policy. Since we are now well aware of some of the assumptions which must go into constructing an overall benefit-cost ratio for a project, and how sensitive the benefit-cost verdict can be to these assumptions, ignoring questions of distribution of nonquantifiable values on the grounds that the issues are unmanageable within the benefit-cost framework is not easily justified. Many people feel that issues of this sort provide the case for leaving the decisions on public investment programs to the political process, which they feel is more successful in dealing with them. Of course, even if this position is granted, this does not preclude utilizing information available through benefit-cost analysis. A set of program alternatives may be vulnerable to very similar political objections or criticisms to those discussed above, yet vary widely in benefit-cost appraisals. Thus, benefit-cost analysis may provide some means of identifying the types of trade-offs between quantifiable benefits per dollar and other goals implicit in choosing one program over another. Further, estimates of benefits and costs could be made which explicitly assign weights reflecting judgments of relative importance of gains and losses according to their distribution over different groups. Such estimates would permit comparison of programs with different distribution effects. The use of weights in this manner would compel decision-makers to make more explicit the distributional judgments upon which their appraisals may be founded.

MODULE VIII: TYING IT ALL TOGETHER

While this learning package is designed to be an introduction to benefit-cost analysis, the framework which it presents covers all of the essential points of a benefit-cost study. (More advanced texts simply present methods for refining techniques already learned.) You should therefore now be able to set up and carry out a fairly comprehensive analysis within the broad benefit-cost framework. In addition, you may now critically appraise benefit-cost studies or claims about projects which you will undoubtedly encounter in the press. The following review should assist you in conducting or evaluating a benefit-cost study.

8.1 Schematic Review of the Benefit-Cost Framework

I) Define the Program Objectives and the Scope of Impact.

II) Specify Program Alternatives.

III) Estimate Program Costs (Opportunity Costs).

- A) Estimate capital or start-up costs (incurred at program's commencement).
- B) Estimate capital and operating costs which will be incurred during program life, and discount to obtain present value of costs.
- C) List any intangible costs associated with setting up program, such as dislocations, aesthetic alterations, etc.

IV) Estimate Program Benefits.

- A) Specify set of all effects (direct, indirect/beneficial, harmful) attributable to program's operation.
- B) Separate:
  - 1) Pecuniary effects - changes in valuation of products, existing facilities or businesses due to shifts in markets stemming from program.

2) Other distributional impacts.

3) "Multiplier" or regional income impact effects.

4) Intangible effects for which no valuation is possible.

C) Sort remaining direct/indirect effects to be valued into categories of:

1) Intermediate effects, whereby program enhances production of final outputs.

Intermediate effects are evaluated by estimating the value of increased production due to the program, minus the costs of all required inputs except those from the program.

2) Final effects, or those received directly from the program by final users or consumers.

Final effects difficult to evaluate; estimates of benefits so provided may refer to what recipients willing and able to pay for them, or the amount of net savings provided over next best alternative; consumer surplus may be important component.

(Check here for possible double-counting of final and intermediate effects.)

V) Identify Externalities.

A) Separate external costs from external benefits.

1) Separate into tangible and intangible.

2) Separate into final versus intermediate for valuation.

VI) Quantification/Valuation of Benefits and Costs.

A) Estimate program output levels over life of program.

B) Estimate demand for program outputs.

C) Estimate price (average) and quantity combination expected in each year of program life.

D) Estimate value of benefits (costs) as: (a) net savings (losses) to users, beneficiaries over alternative, or (b) net contribution to (reduction of) increased value of final output production.

E) Discount net benefits (less cost externalities) using carefully chosen discount rate.

F) Subtract costs from benefits to determine project feasibility (whether $B - C \geq 0$).

G) Perform sensitivity analysis by varying:

1) Discount rate.

2) Time stream of benefits.

3) Time stream of costs.

8.2 Checklist of Principles and Pitfalls

It is easy to overlook factors in conducting a benefit-cost analysis or in evaluating someone else's study. The following checklist of principles and pitfalls should help you critique your own or someone else's work.

1. Are the program effects evaluated as benefits clearly attributable to the program? Are they the net incremental benefits -- net of extra or hidden costs and of possible adverse side effects of the program? Are they the increase in benefits provided by the program, or by other contributing factors?

2. Are externalities considered? If so, does the list seem exhaustive or skimpy? Are these evaluated or simply noted in passing? Are there any clues as to whether externalities are undervalued or overvalued?

3. Does the selection of prices for valuation of inputs and outputs appear reasonable? Are the periods of time from which they are taken unusual for any reason? Have prices been adjusted to take account of government subsidies, price supports or ceilings? Have they been adjusted, where appropriate, for nongovernmental influences on market prices (monopoly or near monopoly prices)? Do they take into account the effect of government outputs on prices?

4. Are all benefits and costs fully discounted where appropriate? What discount rate(s) are used? Do they seem unusually low (less than 8%) or high (over 20%)? What explanations are offered for any such anomalies? Are the rates simply arbitrarily assigned?

5. Are intermediate and final outputs of the program or project clearly labeled? Is there any indication of double-counting of benefits? Are any costs counted as benefits? Are any market or redistribution effects counted as benefits or costs (pecuniary effects)?

6. Are benefits clearly calculated as net savings over alternative sources of supply -- cost of next best or previous alternative?

7. Are employment costs counted as costs (not as job benefits)? Are wage costs adjusted to reflect the true social opportunity cost of employing labor?

8. How are other objectives handled? Are distributional issues considered? How are intangible effects treated?

9. Is there a sensitivity analysis, showing the variations in the benefit-cost ration when discount rates or cost and benefit projections are altered -- singly and together in various combinations -- within the likely or acceptable ranges?

10. Does the benefit-cost study support one of several options, and, if so, are the other options compared within the benefit-cost framework with the favored options? (Are alternatives fairly compared?)

FINAL EXERCISE: Check with your instructor before completing this exercise, since he or she may have an alternative exercise in mind.

Find an example of a benefit-cost analysis in a newspaper such as The New York Times or the Washington Post. (The study need not be identified as a benefit-cost analysis; you may simply recognize it as one.) Using your knowledge of benefit-cost methodology, critically evaluate the study's presentation and findings.

STUDENT EVALUATION FORM

Title of Learning Package: An Introduction to Benefit-Cost Analysis for Evaluating Public Expenditure Programs

Course Title_____ Name of Instructor_____

Specific Parts of Learning Package Which Were Used (If the whole package was used, please indfcate this).

_____

This questionnaire is designed to assist your instructor in evaluating the learning package you have just completed. You should answer the questionnaire in terms of that part of the learning package to which you were exposed. Answer the questions given below by circling the letter which corresponds to the response that most nearly agrees with your own. Please be frank since your comments will play a role in helping your instructor and the Consortium in improving the package in the future.

1. All things considered, this learning package was:

   a. excellent b. good c. fair d. poor

2. To what extent did the learning package help you achieve the stated objectives?

   a. a great deal b. some c. little d. not at all

3. On the whole, how much do you think you learned as a result of the learning package?

   a. a great deal b. some c. not very much d. nothing

4. How would you describe your instructor's attitude toward the package?

   a. enthusiastic b. neutral c. negative

5. Please complete the following statement by circling the most appropriate letter after each adjective. When completing the statement, use the following code:

   a = Extremely b = Very c = Somewhat d = Not at all

   I FOUND THIS LEARNING PACKAGE TO BE:

INTERESTING	a	b	c	d	CHALLENGING	a	b	c	d
BORING	a	b	c	d	A WASTE	a	b	c	d
RELEVANT	a	b	c	d	PRACTICAL	a	b	c	d
INFORMATIVE	a	b	c	d	DEMANDING	a	b	c	d
DIFFICULT	a	b	c	d	DIFFERENT	a	b	c	d
GOOD	a	b	c	d	ENJOYABLE	a	b	c	d
STIMULATING	a	b	c	d	ENLIGHTENING	a	b	c	d
IRRELEVANT	a	b	c	d	EXCITING	a	b	c	d
WORTHWHILE	a	b	c	d	REWARDING	a	b	c	d
VALUABLE	a	b	c	d	PROVOCATIVE	a	b	c	d
NECESSARY	a	b	c	d	GENERAL	a	b	c	d
DULL	a	b	c	d	USELESS	a	b	c	d

6. Listed below are a number of analytic skills which may have been developed as a result of your completing this learning package. By circling the appropriate letter, please indicate the level of competence you felt in each skill before the package was used, and the level of competence you now feel in each skill after having completed the package. Please use the following code:
a = None, b = Little, c = Some, d = A Great Deal.

SKILL	BEFORE				AFTER			
	None	Little	Some	A Great Deal	None	Little	Some	A Great Deal
Identify Government Programs Needing Benefit-Cost Studies	a	b	c	d	a	b	c	d
Recognize Need for and Difficulties in Assigning "Benefits" and "Costs"	a	b	c	d	a	b	c	d
Distinguish Between Program Effects and Benefits and Costs	a	b	c	d	a	b	c	d
Recognize Economic Measures of Benefits and Costs	a	b	c	d	a	b	c	d
Apply Technique of "Discounting"	a	b	c	d	a	b	c	d
Identify "Externalities"	a	b	c	d	a	b	c	d
Recognize Sources of Error in Benefit-Cost Studies	a	b	c	d	a	b	c	d

7. In the space provided, please list the specific ways in which the learning package could be improved.

8. In the space provided, please list those exercises in the learning package which you felt were of little value and indicate how they might be improved.

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